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Research Report 1283

AD A115876

# UTILIZATION OF TACTICAL COMPUTERS FOR TRAINING: SUMMARY REPORT

W.G. Hoyt, A.K. Butler, and P.W. Leung  
System Development Corporation

MANPOWER AND EDUCATIONAL SYSTEMS TECHNICAL AREA

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|--|-------------------------------------|--|
| 1. REPORT NUMBER<br>Research Report 1283   | 2. GOVT ACCESSION NO.<br>AD-A115876 | 3. RECIPIENT'S CATALOG NUMBER  |
| 4. TITLE (and Subtitle)<br>UTILIZATION OF TACTICAL COMPUTERS FOR TRAINING:<br>SUMMARY REPORT   |                                     | 5. TYPE OF REPORT & PERIOD COVERED<br>--                                       |
|  |                                     | 6. PERFORMING ORG. REPORT NUMBER<br>--   |
| 7. AUTHOR(s)<br>W. G. Hoyt, A. K. Baker, P. W. Leung   |                                     | 8. CONTRACT OR GRANT NUMBER(s)<br>DAHC 19-75-C-0031                            |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>System Development Corporation<br>2500 Colorado Avenue<br>Santa Monica, Calif. 90406  |                                     | 10. PROGRAM ELEMENT, PROJECT, TASK<br>AREA & WORK UNIT NUMBERS<br>2Q762722A764 |
| 11. CONTROLLING OFFICE NAME AND ADDRESS<br>U.S. Army Research Institute for the Behavioral<br>and Social Sciences<br>5001 Eisenhower Avenue, Alexandria, VA 22333  |                                     | 12. REPORT DATE<br>May 1976  |
|  |                                     | 13. NUMBER OF PAGES<br>78  |
| 14. MONITORING AGENCY NAME & ADDRESS (If different from Controlling Office)<br>--  |                                     | 15. SECURITY CLASS. (of this report)<br>Unclassified                           |
|  |                                     | 15a. DECLASSIFICATION/DOWNGRADING<br>SCHEDULE --                               |
| 16. DISTRIBUTION STATEMENT (of this Report)<br>Approved for public release; distribution unlimited   |                                     |  |
| 17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)<br>--   |                                     |  |
| 18. SUPPLEMENTARY NOTES<br>--  |                                     |  |
| 19. KEY WORDS (Continue on reverse side if necessary and identify by block number)<br>Tactical computers in training      Courseware development<br>Embedded training                      CAI, AI<br>TACFIRE<br>PLANIT  |                                     |  |
| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number)<br>This is a summary report of the four previous reports which concerned itself with examining the feasibility of using computer-assisted instruction (CAI) as an embedded, individualized training program. This training program is to be used in instructing operational users of the TACFIRE Tactical Data System. The TACFIRE courseware has been developed and produced in five functional areas consisting of independent modular blocks of instruction containing 44 PLANIT lessons and 10 performance based module pretests and posttests totaling approximately 3,600 PLANIT frames. |                                     |  |

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# **UTILIZATION OF TACTICAL COMPUTERS FOR TRAINING: SUMMARY REPORT**

**W.G. Hoyt, A.K. Butler, and P.W. Leung  
System Development Corporation**

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**Office, Deputy Chief of Staff for Personnel  
Department of the Army**

**May 1976**

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**Army Project Number  
2Q762722A764**

**Embedded Training**

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## FOREWORD

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This Research Report is the summary report for four other reports from System Development Corporation under Contract No. DAHCl9-75-C-0031 entitled Utilization of Tactical Computers for Training. The other four reports are: Analysis of System and Training Requirements (RN 80-29); Job/Task and Training Analysis (RR 1281); Field Evaluation Plan (RN 80-30); and Job/Task and Training Analysis - Ammunition and Fire Unit (AFU) Module (RR 1282). Another report under the same contract is entitled Development of CAI Performance Measures: TACFIRE Tactical Data System (RR 1284), although it is not included in this summary report.

Under a research project of this magnitude, many efforts are made by U.S. Army military and civilian personnel in the development of course materials who should be recognized. While space precludes us from thanking everyone, special thanks should go to James Baker, Dr. John Germas, and John Larson from ARI and the following personnel from the U.S. Army Field Artillery School, Fort Sill, Oklahoma: LTC Gene Wilson, LTC Raymond Spigarelli, Major Lowell Martin, Mr. Benjamin Good, III, MGySgt William McLean, M/Sgt. William Wilson, and PFC Stanley Wilson. Also, special thanks to BG Lawrence H. Caruthers, USA (Ret.), who served as a consultant on this project.

  
JOSEPH ZEIDNER  
Technical Director

## EXECUTIVE SUMMARY

The purpose of this project was to examine the feasibility of using computer-assisted instruction (CAI) as an embedded, stand-alone, individualized training program for instructing operational users of the TACFIRE Tactical Data System.

TACFIRE courseware, based upon an analysis of system and training requirements and a Job/Task and Training Analysis, has been developed and produced in five functional areas: Tactical and Technical Fire Control (Fire Mission Module); Artillery Target Intelligence (ATI Module); Ammunition and Fire Unit (AFU Module); Support (SPRT Module); and System (SYS Module). Courseware consists of independent modular blocks of instruction containing 44 PLANIT Lessons (23 Student Lessons) and 10 performance based module pretests and posttests totaling approximately 3,600 PLANIT frames. Average course time for this individualized, self-paced embedded training program is estimated at 40 hours. Preliminary estimates indicate 25% to 30% of battalion fire direction center (FDC) operations are covered. Based on this estimate, for twice the cost of the current effort the remainder can be done. Courseware applies also to DivArty FDC operations, as well as a spin-off to fire support officer (FSO) and fire support element (FSE) operations.

The courseware is well documented. The specific tasks, criterion and enabling objectives, and test items are well defined, having been developed in accordance with the TRADOC Systems Approach to Training (SAT), Systems Engineering of Training, TRADOC Reg 350-100-1, and with the "functional context plus" approach. This approach considers the job (tasks), what the student brings into the learning situation, and how to arrange lesson modules to be maximally supportive of the student during the learning process. The course starts in a context familiar to the student, providing a bridge between his previous experience (manual field artillery) and TACFIRE. This makes it easier for the student to learn, relate, and integrate TACFIRE operations. This approach further provides an organization (course and lesson design) where earlier lessons, such as fire missions (TTFC-FM function), provide the basis and requirement for other operations, such as fire unit and observer location (AFU function). The "why," "effect," and "use" of various operations is made explicit as a natural part of course development. This also makes it easy for the student to learn, relate, and integrate TACFIRE operations. It also provides for repeated reinforcement of TACFIRE operations during the course.

The TACFIRE course executes properly on the TACFIRE system, has been reviewed for content and tactical employment by personnel of the U.S. Army Field Artillery School (USAFAS), and is operationally ready for implementation. The courseware is expected to produce individuals who can perform in an operational setting, under light load conditions, the tasks/jobs covered in the course. An extensive on-the-job-training period of 5 or 6 months should not be required. Further training, such as a carefully planned series of exercises (light load, medium load, heavy load), each stressing various objectives, should result in an operational ready individual within a short time frame.

This program can be used on any TACFIRE system for training, either in a school or field environment.

The courseware is updated quickly and easily as changes in tactical doctrine or equipment occur. This was fully demonstrated during the content review by USAFAS personnel when changes were made on-line as each module was reviewed. Cost of courseware for each additional TACFIRE system is minimal, i.e., the cost of duplicating courseware computer tapes and printing additional copies of the off-line course exhibits.

Automated instruction (AI) can be developed for all the functional areas. There are no methodological restrictions. The determining factor for those selected for this project was that they were more critical for fire direction.

Recommendations include:

1. Complete the courseware development to provide a permanent embedded training program, easily modified to meet changes in tactical doctrine and equipment, and easily duplicated to as many TACFIRE systems as required.
2. Use courseware to provide orientation and initial exposure to TACFIRE.
3. Use TACFIRE AI Module tests to determine need for refresher training.
4. Use the methodology and restructure the TACFIRE AI course for command and staff personnel who are not "direct" users of the system.
5. Use the proven methodology and inherent classification of the system components to develop a classified AI training program applicable to nuclear weapons.
6. Develop a simplified reference manual for ACC operators.
7. Develop a computerized production system for generating exercises.
8. Develop embedded training programs for other tactical data systems.
9. Develop or use TACFIRE modules to train reserve units affiliated with active Army units.

Documentation produced in this project, in addition to this final report, are as follows:

TM-5544/000/00, Utilization of Tactical Computers for Training: Analysis of System and Training Requirements, 20 June 1975. (Research Note 80-29)

TM-5544/001/00, Utilization of Tactical Computers for Training: Job/Task and Training Analysis, 20 August 1975. (Research Report 1281)

TM-5544/002/00, Utilization of Tactical Computers for Training: Field Evaluation Plan, 5 December 1975. (Research Note 80-30)

TM-5544/001/01, Utilization of Tactical Computers for Training: Job/Task and Training Analysis - Ammunition and Fire Unit (AFU) Module, 1 March 1976. (Research Report 1282)



TACFIRE AI courseware and module tests in the form of card decks, course listings, and off-line course exhibits.

# UTILIZATION OF TACTICAL COMPUTERS FOR TRAINING: SUMMARY REPORT

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## UTILIZATION OF TACTICAL COMPUTERS FOR TRAINING: SUMMARY REPORT

### Section 1: INTRODUCTION

#### A. PROBLEM

Computerized tactical data systems for military command and control provide accurate, rapid methods of data transmission and computer generated solutions (aids) in problem solving and at the same time keep track of and update the status of the tactical situation. Translated into field artillery terms, this capability provides computerized Tactical and Technical Fire Direction and Control which is fast and accurate. The computer does most of the work automatically, both much faster and more accurately than is possible in a manual system.

With this increased capability comes a requirement to provide trained personnel who can operate and use the system effectively. Computers do only what they are programmed to do and accept data and commands only within the narrow precise range that meet the parameters, format and procedures established. Computers must also have data bases established and stored in the computer in order to carry out the various functions which they are programmed to do.

The problem is to train Army personnel to operate the system. No matter how good a computerized system is in design and application, if you do not have people capable of operating it, the system is not effective.

#### B. BACKGROUND

The U.S. Army has several efforts currently underway to develop and field tactical data systems such as TACFIRE. As a result it is likely that there will be a considerable data processing capability at the tactical level during 1980. During peacetime, the conduct of tactical operations may not fully utilize this capability. A potential secondary role for these systems, when they are not required for tactical operations, is that of supporting unit and individual training requirements for the users of the system.

As part of a long-range plan, the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) is engaged in an effort to maximize the utilization of recent advances in educational technology to tactical training needs. The results of the recently completed MASSTER Test 122, "IBCS: Automated Instruction," conducted by ARI, demonstrated the feasibility of using a prototype tactical data processing system (DEVTOS) in a stand-alone mode in support of soft-skills unit training requirements--in this case MOS and GED training of 11B40 personnel.

Another aspect of training could be aided by using such tactical systems in a self-instructive mode. Because of their many unique and complex features, tactical ADP systems present special problems with regard to the training of system users. The users in this case are senior staff officers, action officers, and other operational personnel whose absence would seriously degrade

unit efficiency if they were withdrawn from the units and sent away to school for training on how to use these systems. The development and implementation of embedded training could provide sound, standardized training in the unit, reducing or eliminating the need to send personnel away to school.

An additional advantage of the embedded training notion is that it makes tactical data systems more "approachable." Personnel eventually selected for TACFIRE training will have little or no experience with computers. TACFIRE is a complex computer system and a novice user is likely to come away from the initial encounter with more than a bit of timidity. Capitalizing on the novice user's manual field artillery experience and the operational simplicity of the computer assisted instruction (CAI) embedded training, CAI lessons present familiar material in a simple fashion and make the crucial, initial user-machine contact a positive experience.

The overall aim of the present effort is to extend the scope of the application of CAI to the development of self-instructive programs and procedures for users of tactical data processing systems. That is, the basic approach is to embed training subsystem packages within the operating system and then to use the system itself to train the user. This requires that an examination be made of techniques to aid the user in learning how to use the system, to exercise and update his system-related skills, and to provide on-line situation problems which will enable the user to exercise all of his skills in consort. This overall effort will require the development of new techniques which can economically provide intensive individualized, nonscheduled instruction with guided and monitored practice and remedial training.

In May 1975, ARI began to develop embedded self-instruction programs for users of the TACFIRE system. The author-student CAI language for these programs is the PLANIT AI language which was also used for MASSTER Test 122.

#### C. PURPOSE

The purpose of this work is to demonstrate and evaluate the potential for utilizing tactical computers when they are not required for tactical operations. This is done to meet general and specific training needs of system users of tactical units. The demonstration involves the development of training modules for TACFIRE, a prototype system designed to provide computerized control of artillery fires.

#### D. OBJECTIVE

The objective of this project is to develop CAI courseware appropriate for training users of the TACFIRE system. This courseware will provide the foundation for subsequent evaluation and refinement of CAI technology for training on tactical systems.

This objective was divided into five sub-objectives or phases as follows:

Phase I - Analyze System and Training Requirements

Phase II - Perform Job/Task and Training Analysis

Phase III - Develop Courseware

Phase IV - Install Courseware

Phase V - Develop Field Evaluation Plan

Each of these phases is described in the following sections.

## Section 2: PHASE I - ANALYZE SYSTEM AND TRAINING REQUIREMENTS

The purpose of Phase I was to identify those user-related functions or operations that are required for the conduct of tactical operations. Selected functions or operations then provide the framework for the development of automated self-instructional programs and procedures for training users of the TACFIRE tactical data system.

Phase I activities were based upon an analysis of the available TACFIRE documentation and the system engineering of TACFIRE training documentation (in process at the time) available at the U.S. Army Field Artillery School, Fort Sill, Okla.; discussions with TACFIRE personnel at the U.S. Army Field Artillery School (USAFAS), Fort Sill, Okla., and the TACFIRE project personnel at the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), Alexandria, Virginia; and initial familiarization and briefings on the TACFIRE equipment at the U.S. Army Computer Systems Command MELPAR facility and at the U.S. Army Field Artillery School.

The Phase I tasks are shown in Figure 2-1. Each of these tasks is covered in the paragraphs which follow.

### A. REVIEW AND ANALYZE TACFIRE DOCUMENTATION

The purpose of the review was to recommend preliminary functions for training in a CAI mode. The Draft Technical Manuals (DTMs) and the system engineering of training documentation prepared by USAFAS and listed in Appendix A were reviewed and analyzed. Operation of the TACFIRE system at MELPAR and USAFAS was also observed to supplement and clarify the documentation.

TACFIRE is a computerized system which provides rapid and accurate transmission and utilization of field artillery data. It is derived from and based upon the manual field artillery system in that the data, operations, and procedures evolve from the manual system. Computerized control, however, involves a great deal of specificity: precise inputs and the filling in of required fields and subfields allow little margin for error. This control and specificity, however, almost completely automates the process of fire direction and control.

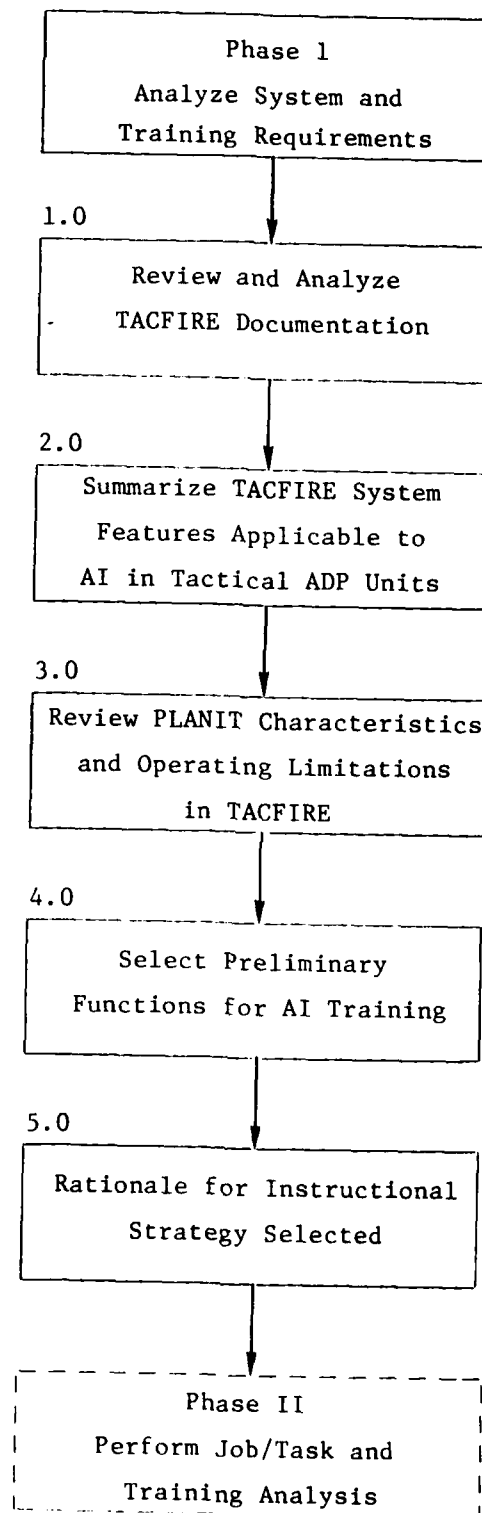


Figure 2-1. Tasks for Phase I. Analyze system and training requirements.



The message formats used are many and varied (over 100 are shown in Figure 2-2), and the data entries required for each format are extensive and precise (Figure 2-3). Valid entries in most instances, however, are those required in manual field artillery fire direction and control. The TACFIRE training problem thus becomes one of associating input data with a specific format, calling up the format, making the entries, and transmitting the data to the units or organizations requiring them (e.g., from the Battalion Fire Direction Center (FDC) to the Division Artillery FDC). Approached in this way, the training task becomes one of associating specific types of formats with requirements specified to a considerable degree by the format itself.

Much of the training problems can be alleviated by maintaining the job orientation, i.e., teach the individual in the context in which he will do the job, and by integrating TACFIRE-specific operations and procedures into the overall known task of carrying out the field artillery mission.

In summary, the training problems which become evident when the new TACFIRE computerized system is overlayed on the known current manual system are:

- Learning the TACFIRE-specific operations, procedures, and restrictions.
- Integrating manual field artillery operations, procedures, and data, i.e., essentially learning when, where, and in what sequence they are used (e.g., what formats are required to carry out a fire mission).
- Learning to operate at the high level of specificity, e.g., target designation, and extremely precise procedures required by the computer system.
- Learning the procedures required when "normal" TACFIRE procedures do not result in mission accomplishment. That is, the steps required to circumvent problem situations.

#### B. SUMMARY OF THE TACFIRE SYSTEM FEATURES APPLICABLE TO AI IN TACTICAL ADP UNITS

The TACFIRE System is an automatic data processing (ADP) system used in artillery fire planning, fire mission processing, and supporting tasks. The system comprises computer centers for Division Artillery Fire Direction Centers (DivArty FDCs) and field artillery battalion FDCs, remote devices for field artillery missile unit FDCs, fire support elements (FSE) at the division command post, fire support officers (FSOs) at supported maneuver battalion and brigade command posts, forward observers (FOs) and firing batteries.

The DivArty FDC is the central data processing point for the system. Bn FDCs are also data processing points for the artillery battalions but rely on the DivArty FDC for tactical coordination and planning assistance. Additionally, the division FSE uses DivArty data processing capabilities for fire support coordination, computations, and determinations.

| TFTC function (Fire Mission)           | Ammunition and Fire Unit Function | Survey Function         |
|--|-----------------------------------|-------------------------|
| FM;DIR                                 | AFU;DIR                           | SURV;DIR                |
| FM;RFAF                                | AFU;UPDATE                        | SURV;TPAC               |
| FM;SUB                                 | AFU;BAMOU                         | SURV;SCPST              |
| FM;QF                                  | AFU;MV                            | SURV;SVTP               |
| FM;NUKE                                | AFU;MASK                          | SURV;TPR                |
| FM;INTM                                | AFU;REG                           | SURV;CRITER             |
| FM;HBMPI                               | AFU;AMOL                          | SURV;PRTSVY             |
| FM;OBCO                                | AFU;ASR                           | SURV;SEND               |
| FM;COMD                                | AFU;MFR                           | SURV;DELET              |
| FM;MOD                                 | AFU;MFN                           | SURV;AZDIST             |
| FM;FUSEL                               | AFU;BUILD                         | SURV;AZALT              |
| FM;XCLUDE                              | AFU;COMD                          | SURV;AZHR               |
| FM;ATTACK                              |                                   | SURV;FAZ                |
| FM;FC } output                         |                                   | SURV;TRAV               |
| FM;EOM } by                            |                                   | SURV;TRADJ              |
| FM;CHECK) computer                     |                                   | SURV;CCC                |
|  | Support Function                  | SURV;INTER              |
| Non-nuclear Fire Plan Function         | SPRT;DIR                          | SURV;TRIANG             |
|  | SPRT;MAP                          | SURV;SINT               |
|  | SPRT;DPM                          | SURV;TRILAT             |
|  | SPRT;GEOM                         | SURV;RE2                |
|  | SPRT;ZNE                          | SURV;RE3                |
|  | SPRT;AIRCOR                       |                         |
|  | SPRT;COMD                         |                         |
|  |                                   | Meteorological Function |
| NNFP;DIR                               |                                   | MET;DIR                 |
| NNFP;COMFP                             |                                   | MET;CM                  |
| NNFP;INST                              |                                   | MET;CW                  |
| NNFP;RESFU                             |                                   | MET;COMD                |
| NNFP;FPTU                              |                                   |                         |
| NNFP;FPA                               |                                   |                         |
| NNFP;EXECFP                            |                                   |                         |
| NNFP;COMD                              |                                   |                         |
| NNFP;MOD                               |                                   |                         |
| NNFP;FUSEL                             |                                   |                         |
| NNFP;XCLUDE                            |                                   |                         |
| NNFP;ATTACK                            |                                   |                         |
| Artillery Target Intelligence Function |                                   |                         |
| ATI;DIR                                |                                   |                         |
| ATI;CDR                                |                                   |                         |
| ATI;AZR                                |                                   |                         |
| ATI;SHR                                |                                   |                         |
| ATI;MFR                                |                                   |                         |
| ATI;SVL                                |                                   |                         |
| ATI;CBTI                               |                                   |                         |
| ATI;QUERY                              |                                   |                         |
| ATI;SRI                                |                                   |                         |
| ATI;PREFP                              |                                   |                         |
|  | System Function                   |                         |
|  | SYS;DIR                           |                         |
|  | SYS;PDS                           |                         |
|  | SYS;FCM                           |                         |
|  | SYS;PCLD                          |                         |
|  | SYS;SBT                           |                         |
|  | SYS;LGSB                          |                         |
|  | SYS;AUTH                          |                         |
|  | SYS;COMSEC                        |                         |
|  | SYS;ADDR                          |                         |
|  | SYS;INIT                          |                         |
|  | SYS;MISC                          |                         |
|  | SYS;PTM                           |                         |
|  | SYS;FORM                          |                         |
|  | SYS;MDS                           |                         |
|  | SYS;FSO                           |                         |
|  | SYS;RD ) COMM messages            |                         |
|  | SYS;CED ) to                      |                         |
|  | SYS;NORM) computer                |                         |

Figure 2-2. TACFIRE message formats.

```

;P: ;SB: / / / / ;C: ;SG: , ;DT: , / / ;ID: ;A: ;
AFU;BAMOUN;FU: / /C/1 /40 ;AMOR: ;AMOE: ;AMOH:X;PLAN: ;STDODD:H/O;
PROJA:HEA1/H/ 33.0/606 ,HEC1/F/ 33.0/606 ,SMA1/S/ 33.0/133 ;
PROJB:SMB1/M/ 33.0/228 ,SMC1/E/ 33.0/6 ,SMD1/K/ 33.0/12 ;
PLOT:M67 /H/606 ,M67 /0/1044,M67 /F/1401:DTG: / / ;
FZES:PDA /282 ,PDC /60 ,TIA /132 ,TIB /678 ,TIJ /258 ,VTC /360 ;BKUP: ;
MYIELD: / / , / / , / / , / /

```

Figure 2-3. Example of a TACFIRE message format - AFU;BAMOUN.

From an operator standpoint, three basic devices are used to communicate with, provide inputs to, and/or modify data in the TACFIRE System. These are: (1) the artillery control console (ACC), which is part of the computer and display group in the Bn and DivArty FDCs; (2) the VMED (Variable Format Message Entry Device) used by FSOs and FSE personnel, and (3) the DMD (Digital Message Device) used by FOs. Figure 2-4 depicts the location of relevant operations personnel and devices.

Devices which only receive and print or display in the TACFIRE System are: the digital plotter map (DPM) and electronic line printer (ELP), which are output (only) devices in the FDCs; the BDU (Battery Display Unit) at the firing battery, which receives (only) firing commands from the Bn FDC, and the ETD (Electronic Tactical Display) at the DivArty FDC. Each of these devices is controlled by operator action at the ACC.

Although a computerized system, TACFIRE is based upon the manual field artillery system. Functions of personnel, decisions made, factors considered in decisionmaking, the types of data acted upon, the reporting required, and update of data are the same for TACFIRE as for the manual system. The difference is that the computer provides for the accurate and rapid processing and transmission of data, processing of the fire mission request, calculation of the ballistics solutions, and reminders (warnings) when commander guidance or troop safety limits are exceeded. In order to attain this increased capability, data bases must be constructed in advance and computer format, input requirements, and procedures strictly adhered to.

## C. REVIEW OF PLANIT CHARACTERISTICS AND OPERATING LIMITATIONS IN TACFIRE

### 1. PLANIT Characteristics

PLANIT (Version 2.6) is the CAI system specified for use in TACFIRE automated instruction (AI). PLANIT is an extremely versatile CAI system which lends itself to TACFIRE requirements for course development, course modification, and student interaction. PLANIT courseware can be administered by the author in any stage of its development. Moreover, a complete range of error diagnostics is provided by PLANIT during the operation of the instructional program. Thus the courseware can be edited on-line (or off-line) at any time

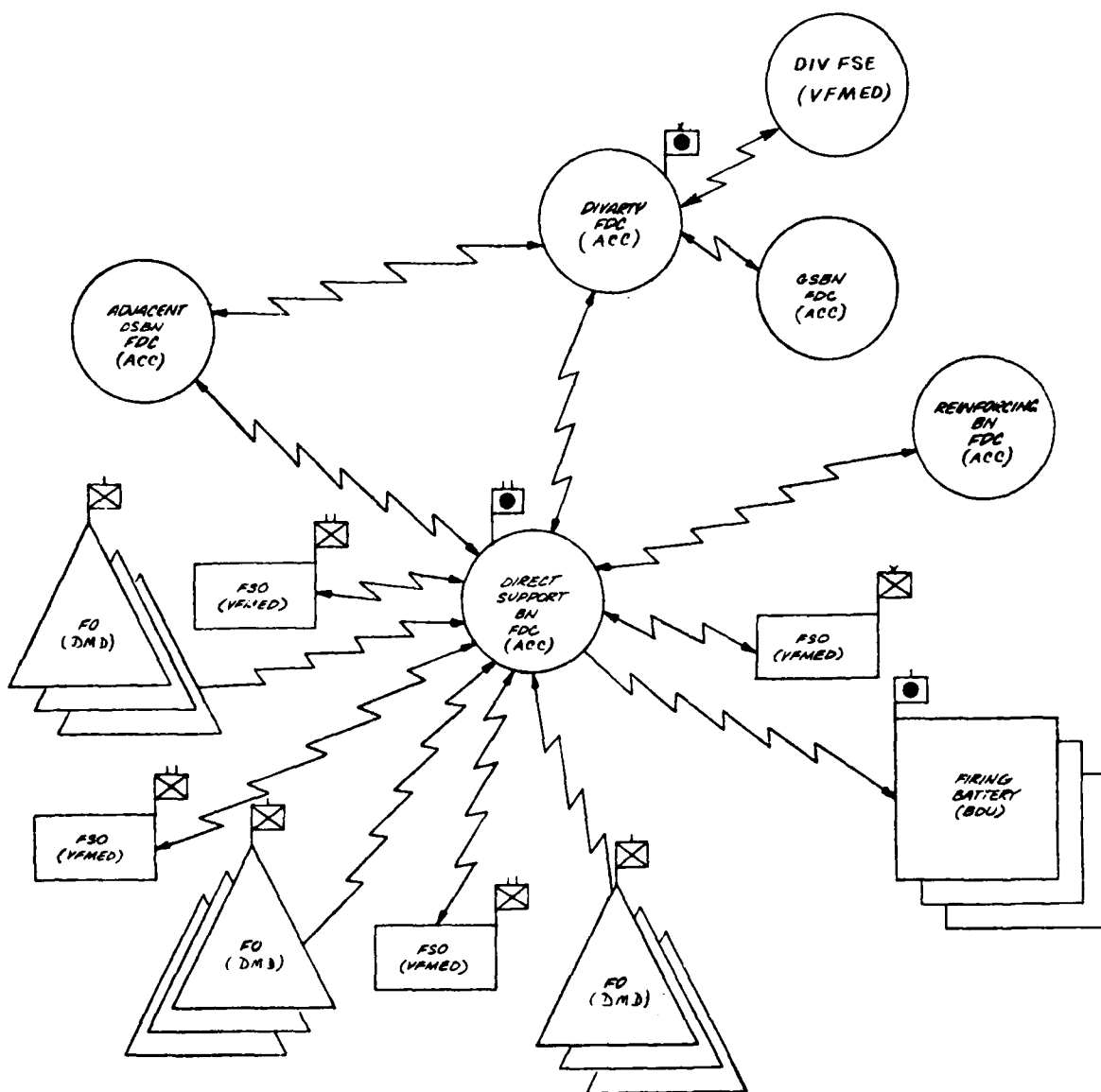


Figure 2-4. Location of TACFIRE operations personnel and devices.

during its construction or operation, accommodating changes to both instructional strategy or course content.

PLANIT has built-in student response processing functions that enhance student interaction. A number of correct and incorrect responses can be programmed for the same question, with feedback and branching to additional course materials appropriate to the skills and knowledge shown by the response. A phonetic comparison capability (PHONETIC) detects words in the response that sound like the prescribed answer but may be spelled differently. A "key word" routine (KEYWORD) requires only that words of the prescribed answer be found embedded in the student's response.

## 2. Operating Limitations in TACFIRE

PLANIT installation on the TACFIRE L-3050 System imposes some operating limitations (parameters) for courseware development. These involve the display limitations of the ACC and VFMED CRT displays, frame characteristics, and character set.

The ACC and VFMED CRT display size is seven lines with 72 characters per line. Display size of courseware is six lines (lines 2 through 7) with up to 70 characters per line. Student response is entered on line 1.

The frame characteristics (maximum parameters) are as follows:

|                       |  |
|-----------------------|--|
| Frames:               | 118 per lesson   |
| Characters per frame: | 1280 (frame buffer size)                                 |
| Labels:               | 44 per lesson  |
| Items:                | 64   |
| Link:                 | 10   |
| On-line users:        | Depends on available consoles (1 ACC and up to 7 VFMEDS) |

The asterisk (\*) from PLANIT (to designate the requirement for a response) is not used. To suppress the asterisk, the \$ facility available in PLANIT was used within each frame. Buffer size presented a problem due to branching and the variable length of feedback. For example, if a frame presentation of six lines has four feedback messages, each with a different number of lines and branching to a different frame, the next frame presentation should not exceed the buffer size. Checkout of the courseware on the TACFIRE produced a number of instances where this occurred. This was easily remedied by shortening or adding a frame.

The character set used was the same as for the IBM 029 keypunch. Courseware was produced on cards using this character set and then converted to tape for loading into PLANIT on the TACFIRE System.

#### D. SELECTION OF PRELIMINARY FUNCTIONS FOR AI TRAINING

##### 1. Selection Criteria

In order to demonstrate the potential for utilizing tactical computers for training, the following criteria and considerations were established as the basis for selection of preliminary functions for AI training:

- Function is critical to tactical operations
- Function is performed frequently
- Function is performed by a significant number of operations personnel
- Functions selected provide a breadth of coverage
- Functions provide continuity within the AI training program, i.e., provide modular independent blocks of instruction. Each modular block should have a specific beginning, a specific end, and logical continuity throughout.

These criteria furnish the basis for the selection process which follows.

##### 2. Areas, Personnel, and Equipment Considered

In the analysis of TACFIRE documentation, operation of the system, and discussions with TACFIRE personnel, it was evident that many of the functions performed at the DivArty FDC and Bn FDC are similar. The major differences, as shown by the USAFAS task lists, are in the intelligence functions at division level and the execution of fire missions at battalion level. Consequently, in selecting preliminary functions for training, the area considered was the Bn FDC sphere of operations, which also covers many functions of the DivArty FDC.

In the TACFIRE Bn FDC an almost complete overlap exists between the tasks for the Fire Direction Officer (FDO) and the Fire Direction Sergeant in that the task lists for the Fire Direction Sergeant cover most of the tasks for the FDO.

It is recognized that the responsibility for operations and decisionmaking rest with the FDO. However, the TACFIRE operational knowledge and skills apply to both. Modules developed for these tasks will not only apply to Bn FDC personnel but will have a fairly wide range of application for DivArty personnel as well.

The equipment involved included the ACC console, the VFMED, and the FO Input Device and because the FO Input Device was being redesigned and the data was unavailable, it was dropped from consideration. The ACC console is used at both Bn and DivArty FDCs, and the VFMED is used by FSOs and division FSE. The ACC console and VFMED operation, consequently, were the areas for consideration.

In summary, the preliminary functions considered for AI training cover the Bn ACC console operation by the Bn FDO and Fire Direction Sergeant and the VFMED operation by the Bn FSO.

### 3. Preliminary Selection of Functions - ACC

Three general areas of tactical and technical fire control were considered. The first was conduct of the fire mission, i.e., processing of fire missions, production of firing data, and the recording and reporting of fire missions. The second was maintaining and updating the data bases that permit tactical and technical fire direction to be accomplished. The third was the system operating messages (SYS) used to initialize and update the FDC files for operation within the FDC and with other subscribers.

#### a. Conduct of the Fire Mission

Most fire missions will be processed simply and quickly. The first lesson in the first module proposed covered the conduct of a simple fire mission in the automatic mode. It further served as an easy, student-centered introduction to TACFIRE, relating the students' manual field artillery experience to TACFIRE and showing the speed and simplicity with which fire missions are carried out. It provided initial experience with the ACC console in a normal job environment within a very familiar situation--conduct of a fire mission. Console actions are learned and carried out in the same way as they are accomplished in the tactical situation. Additional segments cover more complex fire missions, e.g., request for fire from DivArty and voice requests for fire missions.

In selecting additional preliminary functions for conducting fire missions, the functions and message formats in the DTM 11-7440-240-10 volumes (which cover the same areas as the USAFAS task lists) were reviewed. The two areas directly applicable to the conduct of fire missions in the ACC operation are Fire Mission (FM) and Non-Nuclear Fire Plan (NNFP). Within these two areas, each TACFIRE message format (see Figure 3-2) was reviewed as to content, purpose, description, and relationship with other messages, use, and frequency of use.

The content and procedures in the conduct of the FM and the NNFP are similar and in some instances almost the same. However, the Fire Plan Function is a complete entity in itself and a culmination of applications of prior learning. It was anticipated that a partial coverage of this area was inappropriate and difficult for the student to understand unless a full treatment was given and a base of knowledge first established. Because the amount of AI courseware is limited and the FM function and other functions selected cover many of the same skills and knowledge, the NNFP function was dropped from consideration. The specific FM functions recommended are listed in TM-5544/000/00, Utilization of Tactical Computers for Training: Analysis of System and Training Requirements. (ARI Research Note 80-29)

b. Maintaining and Updating Data Bases

The second general area is the maintaining and updating of the data bases that permit tactical and technical fire direction to take place in the computerized TACFIRE environment. Many of these functions (SPRT; AFU; MET; ATI; SURV) require the same set of skills and knowledges which are:

- Receive the message input
- Associate the message with the format required
- Display the format required
- Convert the data into the message format
- Enter the data into the data base
- Transmit messages to appropriate agencies.

The training requirement is to associate the incoming message with the format required, associate the message entries with the format entries, and interpret the error messages as they occur.

Since the skills and knowledges required are the same for the five functions (SPRT; AFU; MET; ATI; SURV) given above, then selection of preliminary functions for AI training depends upon which functions are more critical for fire direction. Based on this consideration, the functions recommended were ATI, AFU, and SPRT. Refer to "Utilization of Tactical Computers for Training: Analysis of System and Training Requirements," (ARI Research Note 80-29) for the areas recommended within each of these functions.

The continuity between topics is maintained by providing an underlying developing tactical situation for the learning process. New console actions required are learned in the sequence they are used in the tactical situation. Actions required are carried through to completion, including requirements to transmit changes to other agencies.

c. System Functions

The last ACC area to be considered was the system operating messages (SYS) used to initialize and update the FDC files for operation within the FDC and with other subscribers. These included the establishment of subscriber tables, addresses, and message addresses and are listed in ARI Research Note 80-29.

This module was also to be developed in terms of the tactical (job) situation, showing the console actions and procedures required and the interrelationship between the system messages.



#### 4. Preliminary Selections of Functions - VFMED

In selecting preliminary functions for the Bn FSO VFMED operation, the same considerations apply as for the ACC, particularly in the maintenance of the job relationship--functional context plus training.

The FSO is particularly concerned with the FM-related functions, including the monitoring of FO requests for fire with the prerogative of stopping the fire mission (check fire) through the FM;CMD or SYS;PTM function. The FSO can initiate requests for fire and adjustment of fire. The FSO is also concerned with data from all major functions (ATI, AFU, SPRT, etc.) which are relative to his area of operations. He provides inputs, monitors the tactical situation or obtains data relative to these functional areas.

The modules developed would also be modular, independent blocks of instruction. A number of these functions for preliminary consideration overlap those considered for the ACC. If, when the functions selected for training are finalized, the overlap of modules (or lessons within a module) remain, the modules developed for the ACC will be utilized for the VFMED directly or adapted to fit the VFMED operation. The former turned out to be the case.

The last module proposed for preliminary consideration covers the turn-on and checkout procedures for the VFMED. This module includes the preliminary control settings for the DDT, ELP, Power Source and Power Junction Box, communication circuits, KG-31, and Display Editor; the power turn-on for the Power Junction Box, DDT, keyboard, and ELP and checks on the DE, DDT, and ELP Fault indicators; checkout of the ELP, keyboard and DE; communication check, synchronization and loop test.

The purpose of this module, in addition to providing training on the turn-on and checkout procedures for the VFMED, is to show the versatility of the AI method of instruction in providing breadth of coverage on all aspects of TACFIRE operations.

#### 5. Summary

In summary, the selection of preliminary functions for AI training centered upon FDO and Fire Direction Sergeant operation of the ACC console and the FSO operation of the VFMED.

The approach to the selection of preliminary functions for AI training was to select a broad coverage of areas, more than could be programmed for AI course development within the scope of the project. These functional areas were reviewed by ARI and the U.S. Army Field Artillery School and the final selection and prioritization of function areas were made accordingly. This selection furnished the basis for the next phase of this project, Phase II, "Perform Job/Task and Training Analysis."

## E. RATIONALE FOR THE PARTICULAR INSTRUCTIONAL STRATEGY SELECTED

A summary of the rationale is as follows:

1. Teach the student within the context of the job.
2. Simplify the learning tasks into easily understood student-managed steps.
3. Replicate the operational environment (operational displays, ELP printouts), reinforce the learning which has occurred, and provide job-performance based testing within and at the end of each lesson and module pretests and posttests.
4. Use error messages within the course and as feedback when invalid data is used to complete the message format.
5. Establish the relationship between TACFIRE format entries and data used in manual field artillery operations. Provide menus from which each student can select what he does not know or is unsure of.
6. Make the courseware independent of the device (ACC, VMED, MIOD) to be used for training.

A fuller treatment of this task and the preceding tasks is presented in the Phase I report, "Utilization of Tactical Computers for Training: Analysis of System and Training Requirements," ARI Research Note 80-29. The Phase I report furnishes the basis for and leads to the Phase II activities which follow.

### Section 3: PHASE II - JOB/TASK AND TRAINING ANALYSIS

This section describes the Phase II activities in the development of TACFIRE Automated Instruction (AI) courseware. The purpose of Phase II was to conduct a detailed job/task analysis of the five functional areas selected for AI training and report the results. The specific steps, which were conducted in accordance with TRADOC Reg 350-100-1, are indicated in Figure 3-1.

Results of this initial Phase II activity were incorporated in "Utilization of Tactical Computers for Training: Job/Task and Training Analysis," August 1975. (ARI Research Report 1281)

In February 1976, additional Phase II activities were required to extend the scope of CAI under development to encompass the full range of the TACFIRE functional area: Ammunition and Fire Unit Function, so as to permit more valid comparisons with traditional methods of instruction. Results of this Phase II activity were incorporated in "Utilization of Tactical Computers for Training: Job/Task and Training Analysis Ammunition and Fire Unit (AFU) Module," March 1976. (ARI Research Report 1282) This document should be considered an addendum and supplement to the August 1975 documented Phase II results. The procedures and products developed for the Phase II activity are discussed in the following paragraphs.

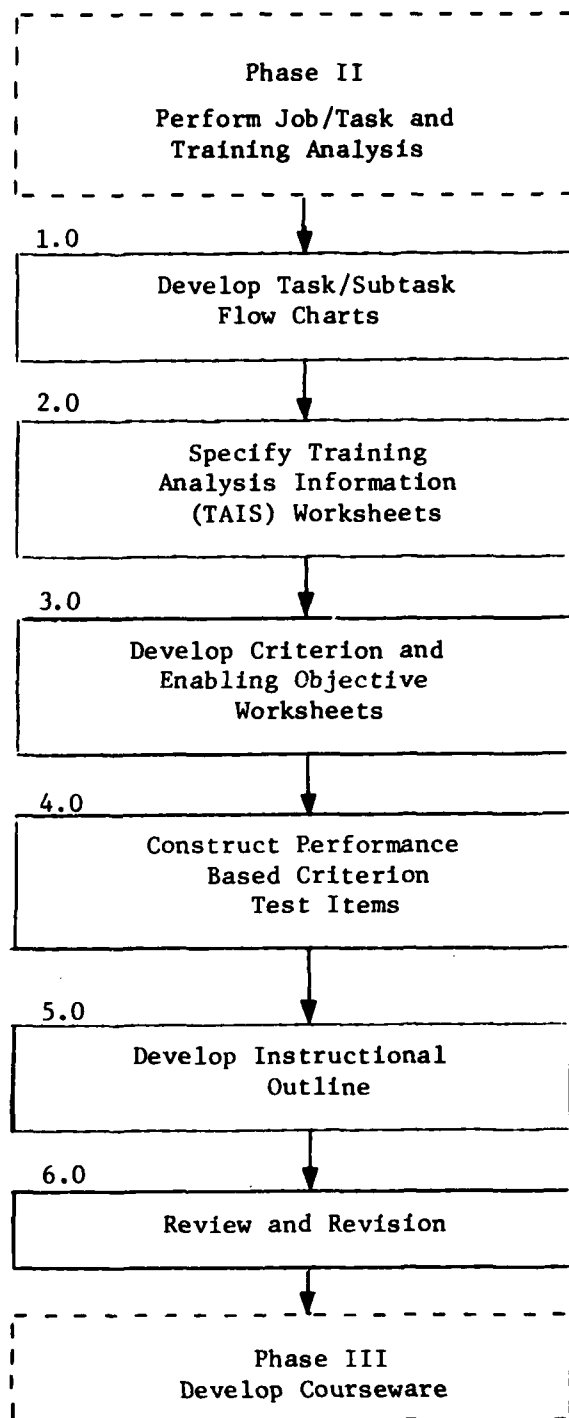


Figure 3-1. Phase II job/task and training analysis-developmental steps.

A. PREPARATION OF TASK/SUBTASK FLOW CHARTS (STEP 1.0 IN FIGURE 3-1)

Task Flow Charts were prepared for each topic within the five TACFIRE functional areas that were selected as a result of Phase I. The Task Flow Chart represents the training tasks, their task elements, and the relationship among them. Figure 3-2 shows a sample Task Flow Chart for the Ammunition and Fire Unit Function (AFU). Task Flow Charts were prepared for the Tactical and Technical Fire Control Function (FM), Artillery Target Intelligence Function (ATI), Ammunition and Fire Unit Function (AFU), Support Function (SPRT), and Operating System Function (SYS). A complete set of Task Flow Charts for the TACFIRE AI materials is contained in TM-5544/001/00 and TM-5544/001/01.

B. PREPARATION OF TRAINING ANALYSIS INFORMATION SHEETS (STEP 2.0 IN FIGURE 3-1)

A Training Analysis Information Sheet (TAIS) was prepared for each topic within the five selected TACFIRE functional areas. The TAIS was used to record the results of the training analysis and to provide behavioral task information leading to the instructional objectives, criterion test items and development of course material. A sample TAIS is shown in Figure 3-3. A complete set of Training Analysis Information Sheets prepared for the TACFIRE project is contained in ARI Research Reports 1281 and 1282.

C. DEVELOPMENT OF CRITERION AND ENABLING OBJECTIVES WORKSHEETS (STEP 3.0 IN FIGURE 3-1)

Instructional objectives serve as a base from which instructional material is developed. Also they lead directly to the development of test items.

Two types of instructional objectives were developed for this project: criterion and enabling. Criterion objectives are end objectives associated with a specific task with each objective specifying the type of behavior required. Such objectives were developed for each task element specified in the Training and Analysis Information Sheets.

Enabling objectives are sub-objectives. They represent a skill or knowledge necessary for successful performance of a given task. These objectives were developed as required to indicate the knowledge and skills required of an individual to master the criterion objective. Figure 3-4 shows a sample Criterion and Enabling Objective worksheet. A complete set of criterion and enabling objectives for the TACFIRE AI materials is contained in ARI Research Reports 1281 and 1282.

D. CONSTRUCT PERFORMANCE BASED CRITERION TEST ITEMS (STEP 4.0 in FIGURE 3-1)

Test items are used to indicate how well the student is mastering the various instructional segments. There are two types of test items: criterion and enabling. These test items are keyed directly to the criterion and enabling objectives.

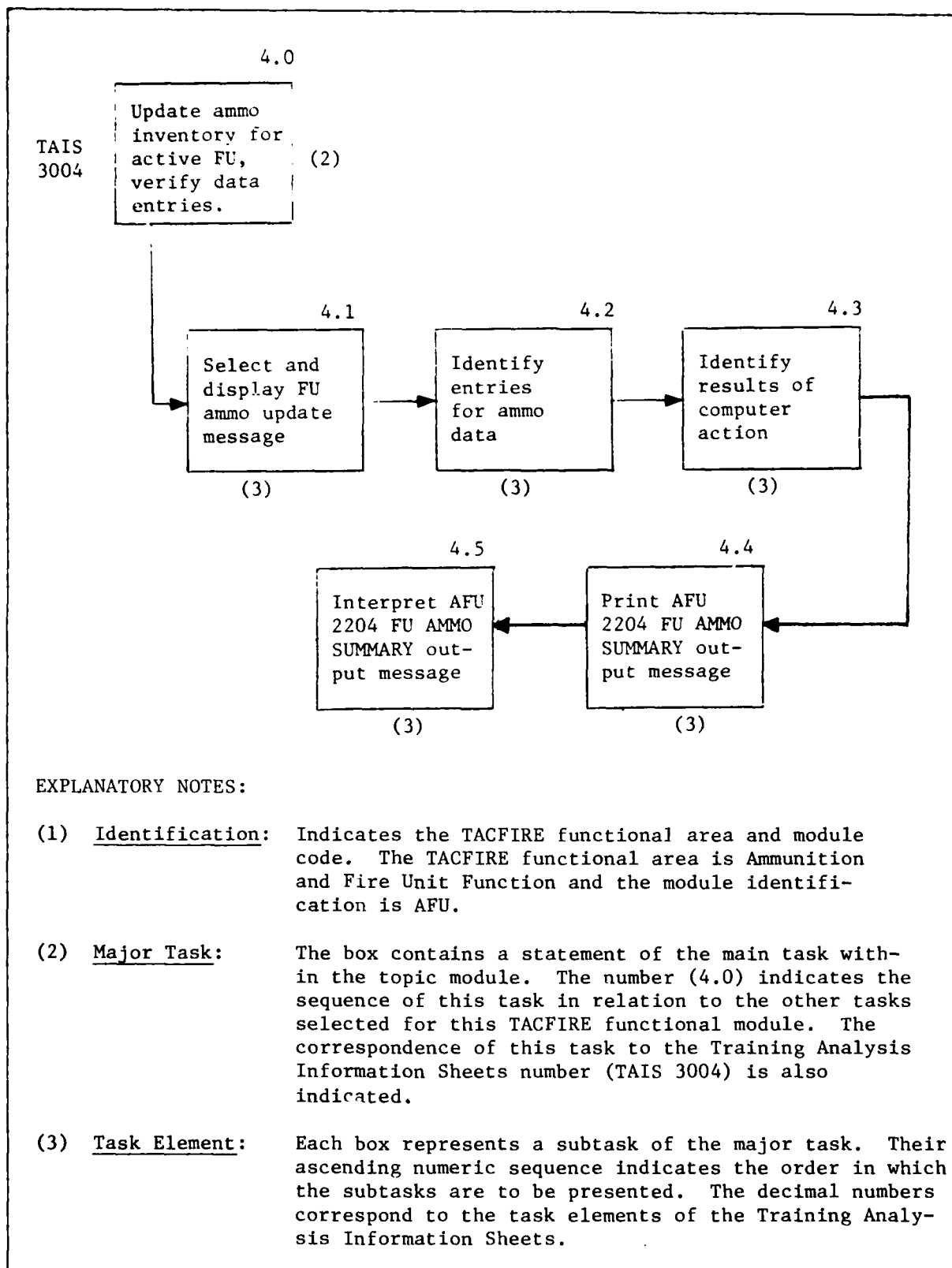


Figure 3-2. Task/Flow Chart for a TACFIRE Functional Area  
Topic: Ammunition and Fire Unit (AFU) Function.

TAIS NO. 3004 (1) (2) MODULE AFU  
UNIT BAMOUP

# TRAINING ANALYSIS INFORMATION SHEET

- (3) 1. TASK IDENTIFICATION: 4.0
- (4) 2. TASK: Update the ammunition inventory for an active FU to select ammunition received and verify data entries.
- (5) 3. CONDITIONS: Given requirements to update current ammunition status of an FU to reflect ammunition received, select correct message format and fill in appropriate entries. Given the requirement to print and interpret AFU 2204 FU AMMO SUMMARY output message, select correct message format to print output message and interpret contents. Given different formatted test items concerning the updating of the ammunition status for an FU and AFU 2204 FU AMMO SUMMARY output message, provide correct response.
- (6) 4. STANDARD: No errors.
5. TASK ANALYSIS:

| TASK ELEMENTS (7)                           | PREREQUISITE KNOWLEDGE OR SKILL REQUIREMENTS (8) | SUPPLEMENTAL TRAINING MATERIAL (9)    | REFERENCES (10)                       |
|---|--|---------------------------------------|---------------------------------------|
| 4.1 Select and display AFU; BAMOUP message. | 4.1 Know operation of ACC component parts.       | 1. Picture/drawing                    | DTM 11-7440-240-10                    |
| 4.2 Identify entries for ammunition data.   | 4.2 Know operation of ACC component parts.       | 2. Entry data and AFU; BAMOUP format. | Chapter 4 Pages 4-159 through 4-176D. |
| 4.3 Identify results of computer action.    | 4.3 None.  |                                       |                                       |

Figure 3-3. TAIS for a TACFIRE Functional Area Topic: Ammunition and Fire Unit (AFU) Function. (sheet 1 of 2)

**EXPLANATORY NOTES:**

- |                                     |  |
|-------------------------------------|--|
| (1) TAIS No.:                       | The TAIS identification number is entered here.  |
| (2) MODULE/UNIT:                    | The module identification - AFU (Ammunition and Fire Unit Function) indicates which TACFIRE functional area this TAIS pertains. The unit designation indicates the specific lesson within the Ammunition and Fire Unit Function. |
| (3) TASK IDENTIFICATION:            | <p>The identification of the task (topic). The initial task identification within each module commences at 1.0.</p> <p>NOTE: This identifier corresponds to the major task on the Task Flow Charts.</p>                          |
| (4) TASK:                           | Statement of the task in behavioral terms.   |
| (5) CONDITIONS:                     | Statements indicating what must be learned and in what context performance must be demonstrated.   |
| (6) STANDARD:                       | The performance standard considered adequate to ensure that learning has occurred under the stated conditions.   |
| (7) TASK ELEMENTS:                  | <p>Each statement corresponds to a task element and is a subtask to the task for which the TAIS is prepared.</p> <p>NOTE: The decimal numbers correspond to the task elements on the Task Flow Charts.</p>                       |
| (8) PREREQUISITE:                   | The knowledge or skill requirements for each task element. Each must be taught or known before instruction on the actual task commences.   |
| (9) SUPPLEMENTAL TRAINING MATERIAL: | Materials that are required to perform the task. These may be SDC-produced off-line pictures and message formats, messages, and reports issued as handouts or on-line presentations.   |
| (10) REFERENCES:                    | The source documentation and materials or interview source from which the training analysis was conducted.   |

Figure 3-3. TAIS for a TACFIRE Functional Area Topic:  
Ammunition and Fire Unit (AFU) Function.  
(sheet 2 of 2)

## CRITERION AND ENABLING OBJECTIVES

- (1) TASK IDENTIFICATION: 4.0  
(2) TASK ELEMENTS: 4.1 - 4.5

| (3) CRITERION OBJECTIVE(S)  | (4) ENABLING OBJECTIVE(S)   |
|---|---|
| <p>4.1 Given a picture/drawing of the ACC switch panel assembly, identify the switch actions that can be used to select and display the AFU;BAMOUP message. The switch matrix is referenced by letters for rows and numbers for columns. The student is able to match the correct letter/number combination to select the required message format. The correct steps are:</p> <ul style="list-style-type: none"> <li>a. Depress switches B and 3.</li> <li>b. Activate FORMAT COMMAND switch.</li> </ul> <p>4.2 Given information to update the ammunition status of an FU to reflect ammunition received, the student will identify the data to simulate the completion of the AFU;BAMOUP input message. Data entries will include:</p> <ul style="list-style-type: none"> <li>• Fire Unit</li> <li>• Ammunition received</li> <li>• Ammunition characteristics</li> <li>• Powder characteristics</li> </ul> <p>(Data to be specified)</p> | <p>4.1.1 Pick from a list the purpose of the AFU;BAMOUP message as being: MAINTAIN AMMUNITION DATA FOR AN FU.</p> <p>4.2.1 State ON THE CED as being where the AFU;BAMOUP will display after being selected.</p> <p>4.2.2 Match the following mnemonics with their definition.</p> <ul style="list-style-type: none"> <li>a. FU - Fire Unit</li> <li>b. AMOR - Ammunition received</li> <li>c. PROJA - Ammunition characteristics</li> <li>d. PLOT - Powder characteristics</li> </ul> <p>NOTE: Explantation of additional mnemonics will be included within the instructional material for student review.</p> |

Figure 3-4. A Criterion and Enabling Objectives Worksheet for a TACFIRE Topic: Ammunition and Fire Unit (AFU) Function. (sheet 1 of 2)



EXPLANATORY NOTES:

- |     |   |   |
|-----|---|---|
| (1) | TAIS No.:<br>MODULE<br>UNIT:<br>TASK IDENTIFICATION | } Same identifications as appear on the TAIS. Each TAIS has a matching Criterion and Enabling Objectives Worksheet. |
| (2) | TASK ELEMENTS:                                      |   |
| (3) | CRITERION OBJECTIVES:                               |   |
| (4) | ENABLING OBJECTIVES:                                |   |
- Numeric code identifying the Task Element
- Criterion objectives are prepared for the Task Element(s) as identified on the corresponding TAIS. A Criterion Objective may be prepared for each Task Element or may include all Task Elements. The number associated with the Criterion Objective identifies the Task Element(s) for which the Criterion Objective corresponds.
- As appropriate, one or more Enabling Objectives are prepared for each Criterion Objective. The number indicates the Criterion-Enabling Objective correspondence and sequence in which the Enabling Objective is to be presented within the instructional material.

Figure 3-4. A Criterion and Enabling Objectives Worksheet for a TACFIRE Topic: Ammunition and Fire Unit (AFU) Function. (sheet 2 of 2)

The following guidelines were adopted to aid in specifying the test items:

- Test items must be performance-oriented and require the student to demonstrate skills and knowledge directly related to the criterion objectives.
- Each test item must elicit measurable behavior.
- The structure of the test item must be positively oriented.
- Multiple-choice items must have at least four alternatives.
- The test item must be amenable to CRT presentation or CRT presentation plus a simple off-line exhibit.

Figure 3-5 shows a sample Test Items Worksheet. Correct answers to test items are shown in two ways:

- Constructed response answers are enclosed within parentheses and underlined. Alternative responses may be included along with the correct response but are not underlined. For example, (Open/Closed) indicates "closed" is the correct response.
- An asterisk (\*) precedes the correct alternative for multiple-choice test items.

A complete set of criterion and enabling test items for the TACFIRE AI materials is contained in ARI Research Reports 1281 and 1282.

#### E. DEVELOP INSTRUCTIONAL OUTLINES (STEP 5.0 IN FIGURE 3-1)

An instructional outline was developed for each selected TACFIRE functional area to provide a working content outline and basic linear sequence for development of the AI materials. The training analysis products (Training Analysis Information Sheets, Objectives and Test Items Worksheets) provided the basis for this instructional outline development. Objectives and test items were sequenced within the outline according to the following priorities:

- By the order in which tasks are normally performed in the TACFIRE job setting.
- By difficult or proficiency level whenever a specific job/task sequence was not apparent.
- By learning task (facts, rules, concepts, decisions, etc.) when neither of the above is appropriate.

A sample content development outline is shown in Figure 3-6. A complete set of content development outlines is contained in ARI Research Reports 1281 and 1282.

|   |  |  |
|---|--|--|
| TAIS No. <u>3004</u> (1)  |  | (1) MODULE <u>AFU</u>  |
|   |  | UNIT <u>BAMOUP</u>   |
| TEST ITEMS  |  |  |
| (1) TASK IDENTIFICATION: 4.0  |  |  |
| (2) TASK ELEMENTS: 4.1 - 4.5  |  |  |
| (3) CRITERION ITEM(S)   |  | (4) ENABLING ITEM(S)   |
| <p>4.1 Refer to Figure _____. Assume one of the fire units in your Bn has received additional supplies of ammunition which must be added to their ammunition inventory. As a first step you need to select the message format so that you can enter this information and update the ammunition status for the FU. From the list of steps given below, first <u>select</u> the procedural steps required and then <u>place</u> them in the correct order.</p> <p>a. Activate FORMAT SELECT switch.</p> <p>*b. Activate FORMAT COMMAND switch.</p> <p>c. Activate REPLACE switch.</p> <p>d. Depress switches G and 3.</p> <p>*e. Depress switches B and 3.</p> <p><u>(e, b)</u></p> |  | <p>4.1.1 The AFU;BAMOUP message is used to:</p> <p>a. Maintain data on backup units.</p> <p>b. Assist Bn in maintaining Battery availability files.</p> <p>*c. Maintain ammunition data for an FU.</p> <p>d. Set amount of ammunition that can be expended by each Battery.</p> <p>4.2.1 After being selected by the appropriate switch actions, the AFU;BAMOUP message format will appear on the (RD/<u>CED</u>)?</p> |

Figure 3-5. A Test Items Worksheet for a TACFIRE Topic:  
Ammunition and Fire Unit (AFU) Function.  
(sheet 1 of 2)

EXPLANATORY NOTES:

- |  |   |   |
|--|---|---|
| (1) TAIS No.:<br>MODULE:<br>UNIT:<br>TASK IDENTIFICATION:  | } | Same identifications as appear on the TAIS and on the Criterion and Enabling Objectives Worksheets.   |
| (2) TASK ELEMENTS:   | } | Same numeric code identifying the Task Elements as appears on the Criterion and Enabling Objectives Worksheet.  |
| (3) CRITERION ITEM(S):<br><br>NOTE: Correct answers to criterion and enabling test items are indicated by an * for multiple-choice items and an underscore for constructed response items. | } | Criterion items are prepared for each criterion objective. Thus, the criterion item may correspond to one or more Task Elements depending on whether they have been combined. The statement labeled CONDITIONS on the TAIS is used to derive the content and context of the text item. The number associated with the Criterion Item identifies the Criterion Objective for which it corresponds. |
| (4) ENABLING ITEM(S):  |   | Enabling Items are prepared for each enabling objective and serve to test the individual skill and knowledge that is required for successful performance on each criterion objective. The number indicates the Enabling Objective-Enabling Item correspondence.   |

Figure 3-5. A Test Items Worksheet for a TACFIRE Topic:  
Ammunition and Fire Unit (AFU) Function.  
(sheet 2 of 2)

| <u>Ammunition and Fire Unit Function</u>   | <u>General Task/Objective (TAIS)</u>   |
|--|--|
| <p>4. Add Ammunition Received to FU File</p> <ul style="list-style-type: none"> <li>a. Select and display AFU; BAMOUP message. <ul style="list-style-type: none"> <li>1) Depress format matrix switches.</li> <li>2) Activate FORMAT COMMAND switch.</li> </ul> </li> <li>b. Identify entries for ammunition data. <ul style="list-style-type: none"> <li>1) FU</li> <li>2) AMOR</li> <li>3) PROJA and PROJB</li> <li>4) PLOT</li> </ul> </li> <li>c. Take computer action and identify results.</li> <li>d. Print and verify entries. <ul style="list-style-type: none"> <li>1) Select and display AFU; COMD message.</li> <li>2) Specify PRINT and SUMS.</li> <li>3) Take computer action and identify results.</li> <li>4) Interpret AFU 2204 FU AMMO SUMMARY output message printed on the ELP.</li> </ul> </li> </ul> | <p>3004 Update the ammunition inventory for an active FU to reflect ammunition received and verify data entries.</p> |

Figure 3-6. A content development outline for a TACFIRE functional area topic: Ammunition and Fire Unit (AFU) Function.

#### F. REVIEW AND REVISION (STEP 6.0 IN FIGURE 3-1)

The results of the Phase II activity were documented as ARI Research Report 1281. During September 1975, at Fort Sill, Okla., this document was subjected to a review by TACFIRE subject matter experts, other interested personnel from the U.S. Army Field Artillery School and ARI personnel. ARI Research Report 1282, reflecting the results of the Phase II activity for the expanded CAI effort for the TACFIRE functional area Ammunition and Fire Unit (AFU) function, was subjected to a similar review during March 1976.

Results of these two review sessions required only minor revisions be made to the training analysis results and change sheets were issued for each respective document to reflect the changes required.

### Section 4. PHASE III. COURSEWARE DEVELOPMENT

Review of the Phase II results finalized the TACFIRE topics selected for CAI development. Subsequent effort focused on developing CAI lessons and adjunct material for the topics shown in the content development outlines following the guidelines established as a result of Phase I.

The work effort was originally targeted for approximately 22 hours of instruction comprising 2,400 frames. With the advent of the expanded effort, these totals increased to approximately 35 hours of instruction comprising 3,200 frames. Module pretests and posttests added another 480 frames totaling approximately 5 hours of on-line tests. Total course time is expected to average 40 hours.

#### A. COURSE DESIGN

The design of each course module is shown in Figure 4-1. The major block of instruction is the course module which represents one of the five TACFIRE functional areas selected for CAI courseware development. Each module is designed to assess the skill and knowledge entry level of the student for the specific TACFIRE functional area. The lessons are designed to enable the student to attain specific knowledge and/or skills that comprise the TACFIRE functional area. The posttest is designed to access how well the student has mastered the material.

Each lesson has been designed to contain five basic elements:

- Preview Element - Introduces the student to the subject matter within the lesson and states the objectives to be accomplished.
- Instructional Element - Provides the instruction to enable the student to meet the criterion established for the instructional element.
- Review Element - Recaps for the student the material presented within the instructional element. Student has the option to cycle through the review element as many times as he desires.

# TACFIRE FUNCTIONAL AREAS

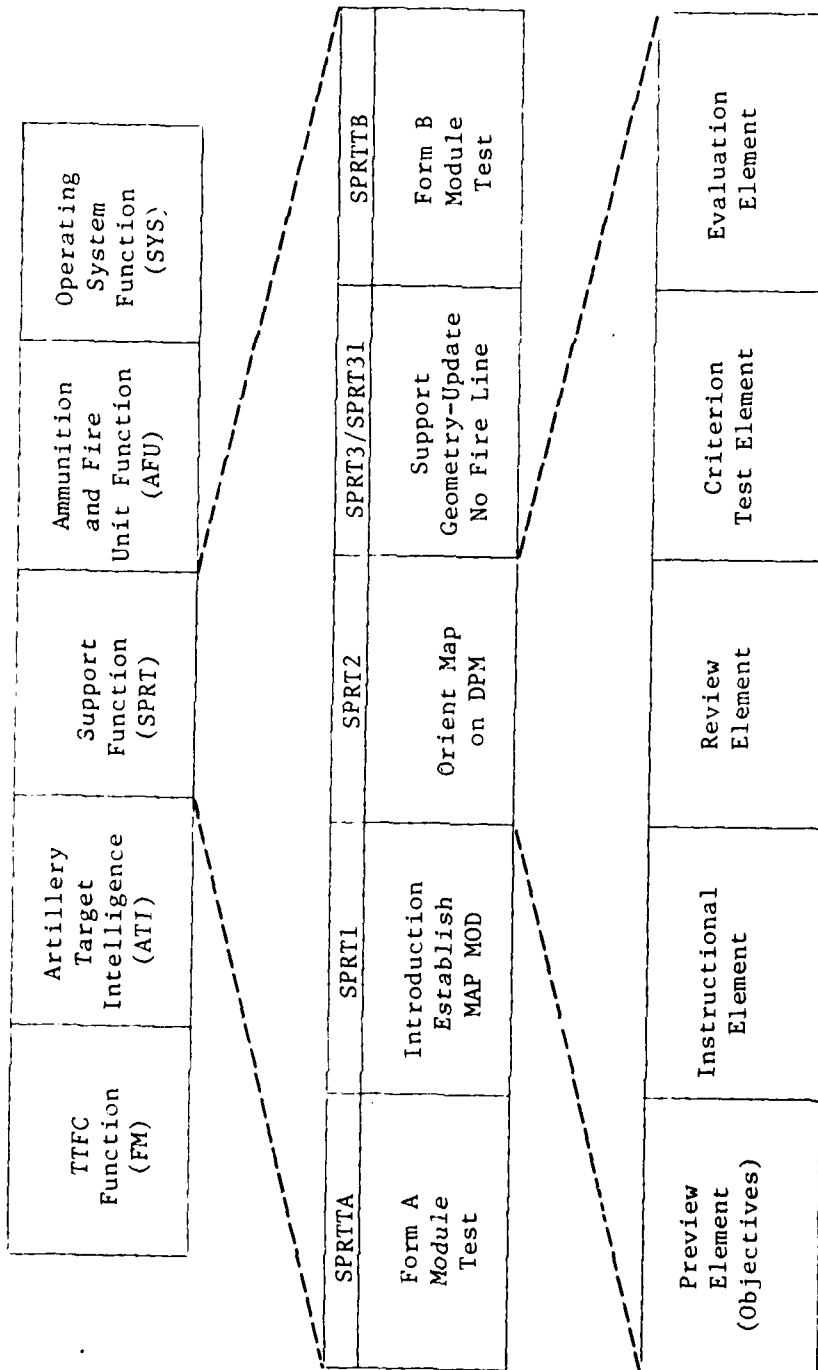


Figure 4-1. Organization of TACFIRE AI courseware.

- Criterion Test Element - Tests the student's mastery of the learning objectives established for the instructional element. Each item is scored and a cumulative score is maintained.
- Evaluation Element - Evaluates the criterion test scores and provides results to the student. Based upon the results, determines whether the student is prepared to proceed to the next lesson within the module or the posttest when the last lesson in the module is completed or selects a remedial path. The remedial options are exposure to the review element followed by the criterion test or exposure to the instructional element and review element followed by the criterion element.

#### B. DEVELOPMENT OF AI MATERIALS

Each topic and task objective specified on the content development outlines became a basic instructional production unit. For each task objective, the associated course topics and subtopics determined a basic instructional sequence. This sequence proceeded from one task objective to the next, with enabling objectives appropriately interspersed.

A series of frames were prepared in conjunction with each task or subtask objective in the course sequence. Enabling test items were interspersed to diagnose individual student difficulties and provide immediate remedial help. Criterion performance items ended each task objective sequence so as to either forward students or to branch them to remedial material or review of earlier material. Each frame in the TACFIRE course was designed to perform one or more of the following functions:

- To present TACFIRE content information, examples of TACFIRE message formats, examples of student interaction with TACFIRE message formats, situational problems, test items, instructions, or lesson control choices to the students.
- To evaluate student responses as correct, incorrect, neutral, or unanticipated.
- To provide feedback messages appropriate to the category of response and, in many cases, to the correct or incorrect response given.
- To decide on the next lesson control action to be taken, i.e., prompt another response, proceed ahead in sequence, branch elsewhere in the lesson, or branch to another lesson or module test.

Lesson authors exercised these basic frame capabilities, using the character presentation, answer matching, and lesson control statements of PLANIT (version 2.6). In creating frames that presented information to the student, lesson authors adhered to several basic ground rules of instructional technique:

- To maintain a functional context training approach by introducing TACFIRE operations and message formats in the order in which they are normally encountered on the job.



- To provide to the student a preview of the instructional topics sequence.
- To inform the student of his performance over sets of subgoals and on each frame requesting a non-neutral response.
- To provide clear instructions, avoiding ambiguity of what is required.
- To keep information and feedback as straightforward and concrete as possible.
- To avoid the use of jargon which does not aid the student in mastering TACFIRE operations.
- To use content examples of TACFIRE message formats, displays, and messages that are relevant to the TACFIRE operational environment.
- To maintain simplicity and continuity of example content by using basic examples as building blocks, so that the focus remains on TACFIRE operations rather than on the content of a particular example.

The CAI applications software used for encoding the on-line instructional materials was PLANIT (Version 2.6), as installed by ARI on the TACFIRE L-3050 System. The display capabilities of the ACC, MIOD, and VFMED devices on which the TACFIRE courseware was to be presented required that the courseware display size be confined to six lines (lines 2 through 7) with up to 70 characters per line. Line 1 of the display was reserved for student responses. To ensure the availability of six full lines of display, the asterisk from PLANIT (to designate the requirement for a response) was suppressed using the \$ facility.

The CAI frames were prepared on sheets from which cards for input to PLANIT could be readily keypunched using the IBM 029 character set. The structure of the frames was, for the most part, free-flowing but did adhere to the PLANIT rules and conventions for developing off-line instructional materials as specified in TM(L)-4422/002/01, PLANIT Language Reference Manual, with one exception: The '@' symbol was used in place of the backslash '\' as the character for controlling a carriage return/line feed.

In constructing the CAI frames, care was taken to ensure that presentation requirements did not exceed the six lines allocated for display. Two of the lesson construction techniques accommodating the display limitation were to require the student to respond with "GO" to advance to the next display or take a continue action (TCA) and to control the presentation and feedback to ensure that subsequent presentations were not forced out of synchronization due to variable feedback. For example, if a frame presentation of six lines has four feedback messages, each feedback message must take up the same number of lines (either text or use of line skips) so the next frame presentation will look the same regardless of which feedback message the student received.

When a set of frames was completed, they were submitted to keypunch operators for conversion to 029 punched cards, and a listing then generated from each set of cards for an initial check. The authors and other project members reviewed the listing for inaccuracies and logical inconsistencies. Corrections

made to the listings were resubmitted for keypunching and the card decks updated accordingly. This production and quality control cycle was repeated until frames were prepared for all the task objectives within a course unit. Card decks of frames representing these tasks were then grouped to form PLANIT lessons from which a listing was produced. The process was repeated for each Module within the TACFIRE AI course.

For control purposes, the frames connecting PLANIT lessons within a module were numbered in ascending order with the number series repeated only if necessary. Frames representing enabling and criterion test items were labeled with a mnemonic formed from the module identifier that appeared on the Criterion and Enabling Objectives Worksheets; e.g., the frame for AFU criterion Item 4.2 was labeled AFU42, while the frame for enabling test Item 4.1.1 was labeled AFU411. This served as a control feature to ensure that all test items were included and as an audit trail between documentation. Other frames were labeled at the discretion of the author to serve as reference points within the instructional material.

#### C. ADJUNCT MATERIALS

Adjunct materials (off-line exhibits) were developed in conjunction with the preparation of the TACFIRE AI materials. In developing the instructional sequences and formulating the frame content, specific points were determined in the instruction where off-line materials were needed to facilitate student comprehension of the task.

Development of these materials was accomplished either by securing copies of pictures and diagrams that were contained in source documentation from the Field Artillery School, and modifying them as required or by preparing original materials. Completed materials for each module were bound separately as handouts for student use.

#### D. ASSESSMENT MATERIALS

Assessment materials for pre- and post-assessment of student performance were developed. Using the Criterion and Enabling Test Items Worksheets, a list of items was prepared. From this list, two test versions (Forms A and B) for each module were established.

Items that appeared in both versions were treated as follows:

- The content of the alternatives contained within multiple-choice items was maintained but the order was scrambled.
- For test items that consisted of a series of steps, or message entry items, different steps or items were selected for inclusion within each version.
- Items requiring constructed responses that did not lend themselves to alteration were inserted at different points within each test version.

#### E. DEVELOPMENT OF PROTOTYPE LESSON

As part of the early courseware development process, a prototype TACFIRE AI lesson was developed which adhered to the guidelines, instructional strategies and production techniques prescribed for developing the remaining TACFIRE AI materials. Purpose of the Prototype lesson was to:

- Ensure the correctness of character conversion.
- Checkout TACFIRE/PLANIT software functions, including PRESTORE, BUILD, editing, lesson execution, and various System Mode Commands.
- Checkout interface of the PLANIT ICU OS with MADCAP OS.
- Demonstrate feasibility of AI within the TACFIRE operational setting.
- Uncover any unforeseen capacity, display, or operational problems.

As a result of the Phase I analysis, the topic selected for development as a Prototype lesson was the conduct of a simple fire mission in the TACFIRE automatic mode of operation.

The Prototype lesson was designed to serve as an introduction to TACFIRE, provide initial experience with the Artillery Control Console (ACC) in a normal operational setting and expose the student to the basic procedures to process a fire mission. Within this instructional content, the Prototype lesson also served to confirm the capability of PLANIT characteristics within the TACFIRE PLANIT environment. The PLANIT lessons FM1 and FM12 served as the Prototype lesson.

#### F. DELIVERY OF COURSE MATERIALS

The Prototype lesson (card decks, listings, and adjunct materials) was completed in August 1975. The card decks were converted into the character set required for operational use in the TACFIRE L-3050 computer.

Subsequent deliveries of completed courseware materials occurred during November and December 1975 and January, February, and May 1976. A 7-track tape was substituted for the card decks commencing with the December 1975 delivery.

#### G. LESSON CONTENT AND DESIGN

The modules are designed as independent units which can be taken in any sequence desired. However, since the Tactical and Technical Fire Control Unit Function (FM) module is designed to provide the student with a basic introduction to TACFIRE (equipment and simple fire mission processing), it is recommended that this module be administered to the student first. Thereafter, the sequencing of the modules can be as desired. Lessons within each module are independent PLANIT lessons but have been sequenced according to the task organization indicated in the Task Flow Charts. The TACFIRE AI course structure is indicated in Table 4-1 and described in the following paragraphs:

Table 4-1. TACFIRE AI Course Structure (Sheet 1 of 2)

| Module                                      | Student Lesson Name | PLANIT Lesson Name | Task Number   | Frame Number  | Number of Frames Lesson | Number of Frames Per Test | Total Frames Instruction | Total Frames Module |     |
|---|---------------------|--------------------|---------------|---------------|-------------------------|---------------------------|--------------------------|---------------------|-----|
| TTFC Function (FM)                          | FMTA FM1            | FMTA FM1*          | 1001          | 1.00- 63.00   | 92                      | 66                        |                          |                     |     |
|   |                     |                    | 1002          | 0.50- 44.00   |                         |                           |                          |                     |     |
|   |                     |                    | 1003          |               |                         |                           |                          |                     |     |
|   |                     | FM12*              | 1004          | 44.20- 76.00  | 47                      |                           |                          |                     |     |
|   |                     |                    | 1005          |               |                         |                           |                          |                     |     |
|   |                     |                    | 1006          | 100.00-195.00 |                         |                           |                          |                     |     |
|   | FM2                 | FM2                | 1006          | 196.00-260.00 | 97                      |                           |                          |                     |     |
|   |                     |                    | FM21          | 1006          | 196.00-260.00           |                           |                          |                     | 69  |
|   | FM3                 | FM3                | 1007          | 300.00-372.80 | 87                      |                           |                          |                     |     |
|   |                     |                    | FM31          | 1007          | 373.00-462.00           |                           |                          |                     | 94  |
|   |                     | FM32               | 1007          | 463.00-558.00 | 98                      |                           |                          |                     |     |
|   |                     |                    | 1008          | 600.00-693.02 | 106                     |                           |                          |                     |     |
|   | FM4                 | FM4                | 1008          | 693.50-728.00 | 37                      |                           |                          |                     |     |
|   |                     |                    | FM41          | 1008          | 693.50-728.00           |                           |                          |                     | 98  |
|   | FM5                 | FM5                | 1009          | 750.00-831.50 | 28                      |                           |                          |                     |     |
| FM51  |                     |                    | 1009          | 831.75-854.00 | 98                      |                           |                          |                     |     |
| FM6   | FM6                 | 1010               | 875.00-936.00 | 33            |                         |                           |                          |                     |     |
|   |                     | FM61               | 1010          | 936.25-966.00 |                         |                           |                          | 984                 |     |
| FMTB  | FMTB                |                    | 901.00-963.00 |               | 66                      |                           | 1116                     |                     |     |
| Artillery Target Intelligence Funtion (ATI) | ATITA               | ATITA              |               | 1.00- 25.00   | 109                     | 27                        |                          |                     |     |
|   | ATI1                | ATI1               | 2001          | 100.00-197.00 |                         |                           |                          |                     |     |
|   |                     |                    | 2002          |               |                         |                           |                          |                     |     |
|   |                     | ATI11              | 2002          | 200.00-239.00 |                         |                           |                          |                     | 41  |
|   | ATI2                | ATI2               | 2003          | 300.00-392.00 |                         |                           |                          |                     | 103 |
|   |                     | ATI21              | 2003          | 400.00-457.00 | 59                      | 312                       |                          |                     |     |
| ATITB                                       | ATITB               |                    | 501.00-525.00 | 28            | 367                     |                           |                          |                     |     |
| Ammunition and Fire Unit Function (AFU)     | AFUTA               | AFUTA              |               | 1.00- 68.00   | 97                      | 69                        |                          |                     |     |
|   | AFU1                | AFU1               | 3001          | 100.00-196.00 |                         |                           |                          |                     |     |
|   |                     |                    | 3002          |               |                         |                           |                          |                     |     |
|   |                     |                    | 3003          |               |                         |                           |                          |                     |     |
|   |                     | AFU11              | 3003          | 200.00-293.00 |                         |                           |                          |                     | 94  |
|   | AFU2                | AFU2               | 3004          | 300.00-393.00 |                         |                           |                          |                     | 94  |
|   |                     | AFU21              | 3004          | 400.00-430.00 |                         |                           |                          |                     | 31  |
|   | AFU3                | AFU3               | 3005          | 500.00-572.00 |                         |                           |                          |                     | 74  |
|   | AFU4                | AFU4               | 3006          | 600.00-689.00 |                         |                           |                          |                     | 91  |
|   | AFU5                | AFU5               | 3007          | 700.00-796.00 |                         |                           |                          |                     | 98  |
|   | AFU6                | AFU6               | 3008          | 800.00-872.00 |                         |                           |                          |                     | 74  |
|   |                     | AFU61              | 3008          | 900.00-938.00 |                         |                           |                          |                     | 39  |
|   | AFU7                | AFU7               | 3009          | 1.00- 97.00   |                         |                           |                          |                     | 98  |
|   |                     | AFU71              | 3009          | 100.00-146.00 |                         |                           |                          |                     | 47  |
|   | AFU8                | AFU8               | 3010          | 200.00-275.00 |                         |                           |                          |                     | 77  |
|   | AFU9                | AFU9               | 3011          | 300.00-385.00 |                         |                           |                          |                     | 87  |
|   |                     | AFU91              | 3011          | 400.00-468.50 |                         |                           |                          |                     | 70  |
|   |                     | AFU92              | 3011          | 468.70-515.00 |                         |                           |                          |                     | 39  |
|   |                     | AFU93              | 3011          | 515.50-583.00 |                         |                           |                          |                     | 69  |
|   | AFUTB               | AFUTB              |               | 601.00-668.00 |                         |                           |                          |                     |     |

Table 4-1. TACFIRE AI Course Structure (Sheet 2 of 2)

| Module                          | Student Lesson Name | PLANIT Lesson Name | Task Number | Frame Number  | Number of Frames Lesson | Number of Frames Per Test | Total Frames Instruction | Total Frames Module |
|---------------------------------|---------------------|--------------------|-------------|---------------|-------------------------|---------------------------|--------------------------|---------------------|
| Support Function (SPRT)         | SPRTTA              | SPRTTA             |             | 1.00- 43.     |                         | 43                        |                          |                     |
|                                 | SPRT1               | SPRT1              | 4001        | 100.00-191.00 | 100                     |                           |                          |                     |
|                                 |                     |                    | 4002        |               |                         |                           |                          |                     |
|                                 |                     | SPRT11             | 4002        | 200.00-232.00 | 33                      |                           |                          |                     |
|                                 | SPRT2               | SPRT2              | 4003        | 300.00-381.00 | 87                      |                           |                          |                     |
|                                 |                     | SPRT21             | 4003        | 400.00-429.00 | 30                      |                           |                          |                     |
|                                 | SPRT3               | SPRT3              | 4004        | 500.00-585.00 | 93                      |                           |                          |                     |
|                                 |                     | SPRT31             | 4004        | 600.00-636.00 | 38                      |                           | 381                      |                     |
|                                 | SPRTTB              | SPRTTB             |             | 701.00-743.00 |                         | 43                        |                          | 467                 |
| Operating System Function (SYS) | SYSTA               | SYSTA              |             | 1.00- 36.00   |                         | 36                        |                          |                     |
|                                 | SYS1                | SYS1               | 5001        | 100.00-188.20 | 95                      |                           |                          |                     |
|                                 |                     |                    | 5002        |               |                         |                           |                          |                     |
|                                 |                     | SYS11              | 5002        | 188.70-212.00 | 26                      |                           |                          |                     |
|                                 | SYS2                | SYS2               | 5003        | 250.00-344.00 | 90                      |                           |                          |                     |
|                                 | SYS3                | SYS3               | 5004        | 400.00-490.00 | 89                      |                           |                          |                     |
|                                 |                     |                    | 5005        |               |                         |                           |                          |                     |
|                                 |                     | SYS31              | 5005        | 500.00-531.00 | 33                      |                           | 333                      |                     |
|                                 | SYSTB               | SYSTB              |             | 601.00-636.00 |                         | 36                        |                          | 405                 |
| Totals                          |                     |                    |             |               |                         | 483                       | 3189                     | 3672                |

1. Tactical and Technical Fire Control Function (FM) Module

a. FM1, FM12 - TAIS 1001 through 1005

Content: Artillery Control Console (ACC), Electronic Line Printer (ELP) and Digital Plotter Map (DPM)

Message Status Line

Communication Line

Processing a Fire Mission in the Automatic Mode

Design: These lessons serve to introduce the student to TACFIRE operations and equipment and the procedures for processing a fire mission while operating in the automatic mode. Fire mission messages are presented to include: requests for fire (FM;RFAF), fire commands (FM;FC), adjust fire and fire for effect (FM;SUBS), end of mission (FM;EOM), and mission fired reports (AFU;MFR). Mnemonic menus are incorporated to facilitate student learning and choice options. Comparisons between manual field artillery and TACFIRE operations are included as appropriate.

These lessons also served as the prototype lessons for system shakedown during the initial courseware development.

b. FM2, FM21 - TAIS 1006

Content: Manual mode fire mission processing

Design: This lesson builds upon the initial lessons. Procedures for manual mode fire mission processing are presented with differences between the manual mode and automatic mode indicated. Additional functions of the FM;SUBS message are discussed with additional drill and practice on FM and AFU mnemonics included.

c. FM3, FM31, FM 32 - TAIS 1007

Content: Process a voice received fire request

Check fire and cancel check fire procedures

Design: The additional procedures to process a voice received fire request when operating in the manual mode are presented. The student learns to select and display the appropriate FM message formats from the format/command matrix, make appropriate entries and take computer action. Implementing and canceling check fire using the ACC command switch is also presented.

d. FM4, FM41 - TAIS 1008

Content: Process a fire request requiring DivArty support

Design: The procedures to process fire requests requiring DivArty support are presented. The student is required to identify and read TACFIRE computer recommendations for DivArty support, use the DELETE switch to remove messages from the receive queue and use the FM;COMD message to transmit a fire request recommending DivArty support.

e. FM5, FM51 - TAIS 1009

Content: Process a quick fire mission

Design: The procedures to process a fire mission against a target established as a known point are presented. The student must interpret FM;QF messages and identify the actions to take. Use of the SPA switches, cursor controls and ACC keyboard keys to edit a message are described with practice exercises interspersed throughout.

f. FM6, FM61 - TAIS 1010

Content: Update location of forward observer (FO) and verify entries

Design: The student learns to select and display the FM;OBCO message format, make appropriate entries, and take computer action. The procedures to verify the observer location entries through the use of FM;COMD message to print an FM 5208 OB LIST output message are presented. The student also receives instruction on the use of the FM;DIR message to select and display FM message formats and the use of the SPA switches SAVE and RESTORE.

2. Artillery Target Intelligence Function (ATI) Module

a. AT11, AT111 - TAIS 2001, 2002

Content: Process ATI Function target location information

Design: These lessons introduce the student to the role of Artillery Target Intelligence Function within TACFIRE and indicates similarities to manual field artillery operations. The student receives instruction on how to select and display the ATI;CDR message, make appropriate entries concerning target location information and take computer action to transmit the information to DivArty. The use of the ATI;DIR message is also presented. Mnemonic menus are incorporated to facilitate student learning and choice options.

b. ATI2, ATI21 - TAIS 2003

Content: Requesting target information from DivArty

Design: The procedures to request target information from DivArty are presented. The student learns to select and display the ATI;SRI message, make appropriate entries, and take computer action. Mnemonic menus facilitate student learning and interpretation of SRI mnemonics. Interpretation of DivArty acknowledge messages and ATI;TGR messages is also covered.

3. Ammunition and Fire Unit Function (AFU) Module

a. AFU1, AFU11 - TAIS 3001 through 3003

Content: AFU function

Fire Unit File and Fire Unit Planning File

Update AFU files and verify entries

Design: These lessons introduce the student to the TACFIRE Ammunition and Fire Unit Function for non-nuclear fire missions. The two basic AFU files are identified and their functions indicated. The student learns the procedures to select and display an AFU;UPDATE message, making appropriate entries, and take computer action. The student also learns the use of the AFU;DIR message to select and display AFU messages. The student receives instruction on how to use the AFU;CMD message to retrieve AFU data for verification and how to interpret the AFU 2203 FU REPORT output message. Mnemonic menus are included to facilitate student learning and choice options.

b. AFU2, AFU21 - TAIS 3004

Content: Add ammunition received to the FU file and verify entries

Design: The procedures to update the ammunition inventory and the types of accounting procedures are presented. The student learns to select and display an AFU;BAMOU message, make appropriate entries, and take computer action. The use of the AFU;CMD message to verify ammunition inventories and interpretation of the AFU 2204 FU AMMO SUMMARY output message is also presented. The use of mnemonic menus is also incorporated to facilitate student learning and choice options.

c. AFU3 - TAIS 3005

Content: Entering current muzzle velocities



Design: The procedures to select and display an AFU;MV message, enter current muzzle velocities and take computer action are presented. The use of the AFU;CMD message to print an AFU 2203 FU REPORT output message and drill on the interpretation of the report is included.

d. AFU4 - TAIS 3006

Content: Enter mask data for a fire unit

Design: The procedures to select and display an AFU;MASK message, enter mask data, and take computer action is presented.

e. AFU5 - TAIS 3007

Content: Process registration data

Delete registration data from AFU files

Design: The procedures to process an ammunition and fire unit registration data input message are presented. Practice on interpreting registration entries is provided as well as mnemonic menus to facilitate learning and student choice options. The student also learns how to select and display an AFU;REG message, identify entries to add or delete registration data and the action to take.

f. AFU6, AFU61 - TAIS 3008

Content: Change critical ammunition level

Establish available supply rate

Design: This lesson covers the use of the AFU;AMOL and AFU;ASR messages. The procedures to select and display each AFU message, make appropriate entries to change the critical ammunition level (AFU;AMOL) and establish the available supply rate (AFU;ASR), and the action to take, are presented. Also, the use of the AFU;CMD message to print an AFU 2204 FU AMMO SUMMARY output message to verify data entries is included.

g. AFU7, AFU71 - TAIS 3009

Content: Process a Mission Fired Report

Establish automatic transmission to a backup Battalion

Design: This lesson builds upon material presented in the FM module. Procedures to process, interpret, and edit AFU;MFR messages are reviewed. Mnemonic menus and drill sequences are incorporated to facilitate student review. New material includes the use of the AFU;CMD message to establish automatic transmission of AFU messages to a backup Battalion.

h. AFU8 - TAIS 3010

Content: Build a new fire plan

Design: The procedures to build a new fire plan from existing data in AFU files is presented. The student learns the steps to select and display an AFU;BUILD message, the entries to make, and the computer action to take. The use of the AFU;CMD message to print an AFU 2203 FU REPORT output message for interpretation and verification is also covered.

i. AFU9, AFU91, AFU92, AFU93 - TAIS 3011

Content: Use of the AFU User Command Message

Design: These lessons present all the major uses of the AFU;CMD message to include: checking for missing fire unit information, causing AFU data to be plotted on the DPM, transmitting AFU data to specified subscribers, and transmitting a situation report to DivArty containing stored data or data not stored (AFU;SR). In addition, the student is given the opportunity to review the use of the AFU;CMD message to edit AFU messages, print AFU reports or control automatic backup transmission. Mnemonic menus and AFU reports are incorporated to facilitate student learning and review.

4. Support Function (SPRT) Module

a. SPRT1, SPRT11 - TAIS 4001, 4002

Content: SPRT function

Establish MAP MOD

Design: These lessons introduce the student to the role of the Support Function within TACFIRE and makes comparisons to manual field operations. The procedures to select and display the SPRT;MAP message so the geographic area of interest (MAP MOD) can be established are presented. The use of the SPRT;DIR message to select SPRT messages is also presented. The student also receives instruction on the use of the SPRT;CMD message to print the SPRT 7201 MAP MOD LIST output message for verification of entries. Mnemonic menus are included to aid student learning and choice options.

b. SPRT2, SPRT21 - TAIS 4003

Content: Orient Map on DPM

Design: The procedures to orient a map to the DPM are presented. The student learns the steps to select and display the SPRT;DPM message, prepare and orient a map on the DPM, enter coordinates and verify that orientation is correct.

c. SPRT3, SPRT31 - TAIS 4004

Content: Enter support geometry and verify entries

Design: The procedures to enter support geometry into the geometry file are presented. The student learns how to select and display the SPRT;GEOM message, make the appropriate geometry entries, and the computer action to take. The use of the SPRT;CMD message to print an SPRT 7202 GEOMETRY LIST output report for entry verification and to have the geometry data plotted on the DPM are covered. Mnemonic menus and display examples are included to aid student learning.

5. Operating System Function (SYS) Module

a. SYS1, SYS12 - TAIS 5001, 5002

Content: Operating System Function

Control peripheral devices

Design: These lessons introduce the use and function of system messages to initialize and update the TACFIRE computer and data files. The procedures to change the status of peripheral devices by using the SYS;PDS message are described. The student learns how to select and display the SYS;PDS message, review and make changes to peripheral device status, and take computer action. Changing the paper package in the ELP is the task example used. Mnemonic menus are included to aid student learning and choice options.

b. SYS2 - TAIS 5003

Content: Change the priority, classification, printing, and display options of TACFIRE messages

Design: The procedures to select and display the SYS;PCLD message, make entries to print the PCLD table (SYS 1201 message), make changes to the PCLD table, and take computer action are presented. Mnemonic menus and sample SYS 1201 messages are used to aid student learning.

c. SYS3, SYS31 - TAIS 5004, 5005

Content: Initialize TACFIRE System

Design: Obtain empty message formats

Design: These lessons present the steps to take to put the TACFIRE system into operation using the SYS;INIT message. The procedures to select and display the SYS;INIT message, make the necessary entries, and take computer action are described. A task situation is to make time and date changes to update the computer clock. The procedures for using the SYS;FORM message to request message formats in the event the

format/command matrix becomes inoperable are presented. Drill sequences with use of the SYS;FORM message are included.

#### Section 5. PHASE IV. INSTALL COURSEWARE

The purpose of the installation of courseware on the TACFIRE System at the U.S. Army Field Artillery School (USAFAS) was to ensure that the courseware could be run (executed) on the TACFIRE Tactical Data System. A second purpose was to have subject matter experts verify the content and accuracy of the courseware.

The actual checkout and subsequent installation of completed TACFIRE AI materials at USAFAS was accomplished in three phases:

- On-line checkout at contractor's facility,
- Conversion and loading of TACFIRE AI materials,
- Installation and checkout at USAFAS.

##### A. ON-LINE CHECKOUT AT CONTRACTOR'S FACILITY

As each PLANIT TACFIRE lesson was completed, the listings produced from the card decks were reviewed and obvious errors and PLANIT programming deficiencies were corrected and also keypunched. The updated card decks were then loaded onto a 370/158 TSO PLANIT system so that the lessons could be executed and subjected to an on-line checkout. Two display devices were utilized: an IBM 3277 CRT terminal, 80 character, 24 line roll-up display, and an IBM 2741 hardcopy terminal.

The purposes of the on-line checkout were:

- Check for PLANIT programming errors,
- Check for instructional clarity,
- Check for keypunching errors,
- Check on branching and instructional sequences.

The focus of this initial checkout was to detect specific types of errors and problems within the TACFIRE AI materials that could be accomplished apart from operating within the TACFIRE system. The PLANIT PRESTORE and BUILD functions were used to detect any illegal frame types or group numbers, illegal frame labels or duplicate frame numbers. Corrections were made on-line as well as to the lesson card decks.

Following this initial check, each lesson was executed at least twice in the author mode; once with only correct student responses and once with only incorrect student responses. As each lesson was executed, particular attention was paid to:

- Instructional clarity; including limits of six line displays, key-punching errors, formatting of Group 2 displays, and logic of instructional branching,
- Group 3 errors; including choice of response processors and anticipated responses,
- Group 4 errors; including branching errors, incorrect use of 'R' commands, and correct placement of internal counters for tracking student progress,
- TACFIRE CRT display requirements; including suppression of PLANIT asterisk, which requests student response, in order to maximize the number of display lines available and checking for the 72 character line limitation.

In addition, correspondence with the appropriate adjunct materials (off-line exhibits) was checked for accuracy and instructional clarity.

Errors uncovered and proposed changes were noted in the listings and revised cards were keypunched and new listings prepared. If extensive changes were required, lessons were reloaded and re-executed on-line. If a minimal number of changes were required, the updated listing was checked.

#### B. CONVERSION AND LOADING OF TACFIRE AI MATERIALS

After conversion of the original card decks or 7-track tapes to the TACFIRE L-3050 character set, the TACFIRE AI lessons were loaded on one or more Tape Transport Cartridge (TTC) devices and shipped to USAFAS.

#### C. INSTALLATION AT USAFAS

A total of 20 evening sessions were required to install the courseware at USAFAS. These sessions occurred during the months of September and November 1975 and March and May 1976 as the courseware was developed and delivered.

The TTCs containing TACFIRE AI materials were loaded into the TACFIRE L-3050 system for on-site installation and checkout. The purposes were to:

- Ensure installation of TACFIRE AI materials within the TACFIRE system,
- Check for lesson fit to TACFIRE limitations,
- Verify content accuracy,
- Check for PLANIT errors.

USAFAS provided several TACFIRE subject matter experts to assist in verifying the lesson content for accuracy and instructional clarity. The on-line checkout sequence was similar to that previously described. Each lesson was executed at least twice in the author mode; once with only correct student

responses and once with only incorrect student responses. The focus of the on-line checkout was to ensure that the courseware executed properly on the TACFIRE system. This included:

- Correctness of courseware display; including 72 character, six line display limitation, and the TACFIRE display buffer limitation,
- Appearance of graphic displays of support geometry, rectangles, message format entries, and other figures on the TACFIRE CRT,
- Aesthetic appearance of displays and sentence formatting,
- Other content corrections and courseware omissions.

Whenever relevant, all Group 3 anticipated responses were checked out. In addition, all branches were executed and correspondence with adjunct materials was verified.

Each lesson was then edited on-line using the PLANIT editing capabilities to correct the errors detected and make the recommended changes. Courseware was re-executed to check editing and the impact of the changes on other frames in the lessons.

At the completion of each on-line checkout session, a PLANIT History Tape was made to preserve the editing changes and provide a backup copy.

#### Section 6. PHASE V. DEVELOP FIELD EVALUATION PLAN

The purpose of Phase V was to recommend an evaluation plan for demonstrating the execution and effectiveness of the entire TACFIRE AI courseware package. The evaluation plan covers: (1) procedures and methodology for performing a review of the TACFIRE courseware content by subject matter experts at the U.S. Army Field Artillery School; (2) procedures and requirements for demonstrating the execution of TACFIRE courseware on the ARI and TACFIRE operating systems; and (3) procedures for assessing the acceptability of TACFIRE AI courseware by field artillery personnel.

The Phase V report "Utilization of Tactical Computers for Training: Field Evaluation Plan," ARI Research Note 80-30, contains the detailed recommendations for the conduct of the field evaluation. Included here is a brief synopsis of the plan.

##### A. REVIEW OF TACFIRE AI COURSEWARE

The review process demonstrates that the training analysis products (criterion and enabling objectives, test items, etc.) and courseware are valid, i.e., they accurately reflect TACFIRE operations, procedures, content, doctrine, and tactical use as employed on the job in the field situation. The review process also ensures that the courseware executes properly on the TACFIRE equipment.

The review process is expected to follow the training development process. Course objectives are reviewed first, then course content and finally, execution of courseware. The audit trail ties these elements together.

#### 1. Review of Course Objectives

The training tasks, criterion and enabling objectives, and test items included in the course are defined in the Phase II report, "Utilization of Tactical Computers for Training: Job/Task Training Analysis," ARI Research Note 80-30, and the supplement for the added courseware, "Utilization of Tactical Computers for Training: Job/Task Training Analysis - Ammunition and Fire Unit (AFU) Module," ARI Research Report 1282.

This portion of the review is to examine the job/task training analysis (Phase II) report and indicate modifications to the criterion and enabling objectives and/or accompanying test items.

The procedure recommended carrying out the review by using copies of the Phase II report to note discrepancies and corrections. The notation should not only identify (mark) the problem area but also indicate why it is wrong.

#### 2. Review of Course Content

This review is concerned with the accuracy of the courseware and consists of an off-line (off computer) check of the accuracy of the course content using the computerized listing (printouts) of the course.

Listings (printouts of course card decks) provide the entire course content including the instructional text, test items, answer processing, feedback, branching, remedial instruction, and decisions made (decision frames) which determine the student's progress through the course.

The procedure recommended is to go through the course with the off-line course exhibits and identify on the listing and/or exhibits discrepancies and questionable areas which may exist along with notations which specify why it is a discrepancy.

#### 3. Review of Execution of TACFIRE Courseware

The TACFIRE AI courseware needs to be run on line to ensure that the courseware can be run (executed) on the TACFIRE computer system and that the frame size including feedback and the following frames fit the configuration of the TACFIRE CRT display (C/ED) and programming parameters. The content should be also checked as the individual frame-by-frame presentation on the CRT may appear different than on the listing, as there is no opportunity to refer to a number of frames at the same time on the C/ED.

The procedures recommended include going through the entire course; once with all correct responses and a second time with all incorrect responses. At the end of each run, PLANIT student records are obtained to determine that the decision frames execute properly.

The problem areas that are identified (content and execution) need to be analyzed to determine the corrective action to be taken. Changes to the courseware are easily made by on-line editing. These changes are recorded on the listing to provide an updated record of the course content.

#### B. TRAINEE ACCEPTABILITY OF TACFIRE AI COURSEWARE

Subject matter experts provide feedback on content validity and organization of the course and the fact that the courseware executes (runs) properly on the TACFIRE system. TACFIRE trainees provide feedback on levels of understanding and mastery and interactive computer behavior, verifying that the courseware executes and is acceptable.

Having TACFIRE trainees take the TACFIRE AI course provides answers to two basic questions: Do they learn the TACFIRE operations specified in the objectives? What attitude do they have toward the TACFIRE AI course? The first question is answered by analyzing trainee results on the criterion tests covering the objectives. The second question is answered by obtaining trainee reaction to the learning process by a structured, semi-open-ended questionnaire upon completion of the course. Implicit in both questions is whether the TACFIRE AI course is "GI proof." Experience with trainees during the evaluation study should provide some indication of this as will earlier runs using military personnel for course checkout.

This section of the report includes: the trainee selection requirements for the study; number of trainees required; equipment, support requirements, and schedule; procedures and forms for conducting the study, including examples of the TACFIRE Course Data sheet, log on and log off instructions; and the TACFIRE Debriefing Questionnaire used in interviewing trainees.

These items are summarized as follows:

1. Trainees selected for the study should meet the prerequisites for the duty position, have a potential assignment to TACFIRE, and have the required visual and reading skills.
2. The number of trainees recommended is 10.
3. The TACFIRE System is required and a two-week liability period for each trainee is recommended.
4. Procedures include the initial activities, taking the course, interview, end activities, and data collection.

The specific procedures to be followed and the rationale for the requirements are included in ARI Research Note 80-30.



### C. ANALYSIS OF THE DATA

The two questions to be answered in the analysis are: Do trainees learn the TACFIRE operations specified in the objectives? What attitudes do the trainees have toward the TACFIRE AI courseware? Answers to the first question are obtained by analyzing the PLANIT trainee records. Answers to the second question are obtained by analyzing the trainee responses to the TACFIRE AI Debriefing Questionnaire.

#### 1. Do Trainees Learn?

Two sets of data should be compiled with summary statistics included. One is in regard to the characteristics of the trainees, the other in regard to their performance.

##### a. Trainee Characteristics

A summary sheet should be prepared showing the data for each trainee on the TACFIRE course data sheet (Figure 6-1). Frequency distributions of each variable should be obtained as well as the mean, standard deviation and range of values for the variable, e.g., GT score, mean = 104.5, standard deviation of 7.5, range 96 to 125. These are compiled to: determine that the selection criteria have been met, for later comparison against course results, and to determine the distribution of these characteristics in the trainee sample.

| Trainee Number | Grade | MOS   | Age | GT Score | Education, etc. |
|----------------|-------|-------|-----|----------|-----------------|
| 1              | E6    | 13E30 | 27  | 108      | 12              |
| 2              | E4    | 13E20 | 22  | 117      | 14              |
| 3              | E6    | 13E30 | 26  | 102      | 12              |

Figure 6-1. Summary of trainee characteristics.

##### b. Trainee Performance

A summary sheet should be prepared showing the course data for each trainee. This includes the time required for each module, the module test score, the total time required for the course and the average of his module test scores. Frequency distributions of each variable should be obtained as well as the means, standard deviation, and range of values for the variable, e.g., FM Module, Module time, mean = 11.2 hours, standard deviation of 1.6, range 9.5 to 14.2 hours.

To answer the question "do trainees learn?" frequency distributions of test scores for each module is examined. High test scores would indicate that the trainees do learn. Low test scores (below 80) indicate the training given is suspect. Further analysis is required and this is done by compiling the frequency distribution of errors (missed time) on the Module test. The

frequency distribution will show which test items (objectives) are problem areas. This part of the module, both content and test items, should be analyzed to determine what the problems are and that either content, test items, or both should be revised.

In addition to the above analysis (and assuming trainees do learn the stated objectives), the relationship of trainee characteristics to learning is of interest. It is suggested that scatterplots be made showing the relationship between such variables as GT, age, education, etc., and test score. The scatterplots will easily show if such a relationship exists.

## 2. What Attitudes Do Trainees Have Toward the TACFIRE AI Courseware?

Answers to the question "What attitudes do trainees have toward the TACFIRE AI courseware?" are obtained by compiling and analyzing the responses to the TACFIRE AI Debriefing Questionnaire. At the same time it will also identify particular problems, if they exist, which can be analyzed and corrected.

The techniques for the analysis are the same as previously stated. A summary sheet is prepared and frequency distributions of the responses to each item are prepared along with the mean and range of values for each response. These are supplemented by the responses of the trainees to the open-ended questions and the additional comments they make.

If the responses of the trainees show that they like the TACFIRE AI course and have little or no difficulty in taking the course, then the TACFIRE AI course can be considered accepted by the trainees. Of particular interest also would be the relation between attitude towards the course and test scores, between age and attitude, length of service and attitude, etc. These can be demonstrated by generating scatterplots showing the two variables under consideration.

## Section 7. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations have been derived as a result of this study on the utilization of tactical computers for training:

### A. CONCLUSIONS

1. TACFIRE AI courseware has been developed in five functional areas: Tactical and Technical Fire Control (Fire Mission - FM Module), Artillery Target Intelligence (ATI Module), Ammunition and Fire Unit (AFU Module), Support (SPRT Module), and System (SYS Module). The TACFIRE AI courseware was developed in accordance with the TRADOC Systems Approach to Training (SAT).
2. TACFIRE AI courseware is well documented. Training Analysis Information Sheets (TAIS), Criterion and Enabling Objectives, and Test Items have been prepared for each task and content development outlines and task/subtask flow charts, for each lesson and module.

The TACFIRE AI courseware in the five functional areas contain 54 PLANIT lessons totaling approximately 3,600 PLANIT frames. The 54 PLANIT lessons contain 10 performance-based module pretests and post-tests and 23 student lessons each containing 1 to 3 PLANIT lessons. Average execution time is estimated at 40 hours.

3. TACFIRE AI courseware executes properly on the TACFIRE system. All courseware has been checked on-line for both correct and incorrect response patterns.
4. The TACFIRE AI courseware content has been reviewed on-line and accepted by USAFAS personnel.
5. The TACFIRE AI courseware content is easily and quickly changed by on-line editing. Changes were made on-line to reflect changes which have occurred to the Draft Technical Manuals (DTMs) and changes to TACFIRE procedures as determined by USAFAS. The change process requires a few seconds and the "new" courseware is immediately available for student execution on the computer.
6. The TACFIRE AI courseware is ready for implementation in both the school and unit setting. It is an individualized, self-paced, self-contained, embedded training program.
7. TACFIRE documentation, specifically the DTMs, is not designed for instructional or quick reference uses. As technical documentation, the manuals cover most aspects in detail, but not in a crossed referenced, easy accessed manner and not for naive readers.
8. AI courseware can be developed for all the functional areas. There are no methodological restrictions. The determining factor for those selected for this project was that they were more critical for fire direction. The tasks and message formats involved within a functional area were generally those that were more complex and longer (more mnemonics) than those not selected.

#### B. RECOMMENDATIONS

1. Provide a Complete, Permanent, Flexible, Embedded TACFIRE AI Training Program

TACFIRE AI courseware has been produced in five functional areas--Tactical and Technical Fire Control (FM - Fire Mission), Artillery Target Intelligence (ATI), Ammunition and Fire Unit (AFU), Support (SPRT), and System (SYS). These five functional areas (and areas within these functions) were selected, not because of restrictions on the AI development process, but because they were considered more critical for TACFIRE operations. The proven methodology and course development procedures used apply to the other functional areas, such as Non-Nuclear Fire Plan (NNFP), Survey (SURV), Meteorological (MET), Fire Support Officer (FSO), and Fire Support Element (FSE). Courseware development for the current project from the Job/Task and Training analysis through on-line checkout and USAFAS content review took 11 months and a relatively small staff (3 to 4

professionals). Considering the number of TACFIRE systems to be fielded and the small cost of replicating courseware for each system (literally cost of duplicating computer tapes and cost of printing additional copies of the off-line course exhibits), the development costs for a permanent, easily updated TACFIRE AI training program is very small. As a hypothetical example, if 40 hours of courseware cost \$180,000 and there were 60 TACFIRE systems on which it would be used, the cost would be \$3,000 for 40 hours or \$75 per hour for a permanent training program for each system.

It is recommended that TACFIRE AI courseware be developed for the remaining functional areas and that the existing courseware in the FM, SPRT, ATI, and SYS be expanded to include those tasks not covered. The current AFU module is practically 100% complete. Such courseware will provide a permanent training program, easily modified to meet changes in tactical doctrine and equipment and easily duplicated to as many systems (and system users) as required. TACFIRE AI courseware can be scheduled and run whenever the system is not being used for tactical operations. The TACFIRE AI course is a self-contained, individualized, self-paced, embedded operational training program that does not require other personnel to carry out, other than the system operator to turn on and load the system.

## 2. Use TACFIRE AI Courseware to Provide Orientation and Initial Exposure to the System

TACFIRE is a complex system and events occur very rapidly. Approximately 20 seconds are "normally" required from the time the FO sends in his request for fire to the Fire Battery receiving the fire commands. This time includes the calculation of the ballistic solutions by the computer and processing of the fire mission at the Fire Direction Center. A demonstration of this process takes about as long and an explanation of what has occurred and learning to do the tasks involved takes much longer.

In a class of 15 or 25 students, it is very difficult for the instructor to explain and the students to learn and integrate the complex TACFIRE actions and interactions that take place. By its very nature, the instruction is geared to a "group" pace and a "group" continuity and understanding which is representative of few individuals. The main stream of the presentation is either too slow or too fast, depending on the individual, and is often interrupted by questions which may clarify or confuse, but in many cases sidetrack the main stream of an individual's learning process. Once lost, the continuity and integration (and motivation) become much more difficult and perhaps impossible for the individual student. Negative attitudes are fostered and motivation to learn is affected. The value and capability of the system is overshadowed by perceived realities that it is a difficult system to learn and operate. This is particularly true in TACFIRE where computer requirements make some things (particularly problem areas) much more difficult to resolve than in the manual system.

The TACFIRE AI training program provides an organized, straightforward easy method to learn and integrate the complex tasks required. It is especially appropriate for the beginning student because it makes the system approachable and reasonable to the student in a setting that allows

him to proceed comfortably at his own pace to reach objectives that are attainable.

It is recommended that the TACFIRE AI program, particularly the FM module, be used for beginning students as their initial orientation and training experience with TACFIRE. This will provide them with a favorable, positive attitude and increase motivation to learn what might otherwise be considered a formidable, complex, and unattainable task.

### 3. Use TACFIRE AI Module Tests to Determine Need for Refresher Training

Refresher training is an ongoing problem, particularly when tactical tasks/skills are not exercised on a day-to-day basis. When a fairly broad area of tasks are required, such as in the TACFIRE system, part of the problem is to identify those tasks or functional areas where refresher training is required for a given individual. An efficient method to do this is to administer tests periodically, in each functional area to determine the individual operational refresher training requirements. The test items in such tests should be tied to specific tasks in the functional area and be tied to specific lessons which cover the operational performance of these tasks so that prescriptive data can be given to the student.

The module tests developed in this project for the five functional areas (FM, ATI, AFU, SPRT, and SYS) meet the above criteria. Test items are tied to the tasks (TAISS), criterion and enabling objectives, and lessons by means of an audit trail. Items in the module test are tagged with the TAIS and test item number. This number is included on the PLANIT student record along with the test item number and whether it was passed or failed. This data furnishes the basis for providing a set of prescriptives identifying which lessons/modules the student should take for his refresher training.

It is recommended that the module tests developed in this project be administered periodically to determine the continued operational readiness of TACFIRE personnel. Such tests will identify specific individual needs for refresher training. Further, it is recommended that additional module tests be developed to cover all functional areas either as a separate project or as an integral part of courseware development. This will provide a permanent, easily updated system of determining the operational readiness and refresher training needs of TACFIRE operations personnel. Once such a determination has been made TACFIRE AI materials may be used to remedy any detected deficiencies.

### 4. Develop a TACFIRE AI Course for Command and Staff Personnel Who Are Not Direct Users of the System

TACFIRE is a new system, with computerized capabilities of speed and accuracy which far surpass present capabilities. Command personnel and staffs need to be aware of what TACFIRE can do for them and what they need to know and do to make the system effective. Artillery fire delivered accurately and quickly on an enemy position is a much desired tactical operation. Command personnel should know what TACFIRE can do for them, how to access the system, and the data requirements (front line

trace, fire coordination lines, etc.) which need to be accurate to begin with and updated in a timely fashion as the tactical situation develops.

This course would be intended for command and staff personnel from company to division level. Taking the course on the TACFIRE system provides firsthand familiarization with the TACFIRE system and the speed and accuracy with which it operates. The course would also dramatically illustrate the need for maintaining the battlefield geometry and other data bases in the computer and methods and access points for entering this data and for utilizing the system.

It is recommended that a TACFIRE AI course be prepared for operations personnel who are not direct users of the system but need to know its capabilities and what it does for them. Such a course would not need to be developed from scratch. Much of the course can be constructed from already existing material in the present TACFIRE AI course. The existing course materials would need to be integrated with new material to be developed which would be based upon the specific objectives of the course and oriented to the needs and characteristics of command personnel and their staffs.

5. Develop a Classified TACFIRE AI Training Program Applicable to Nuclear Weapons

The employment of nuclear weapons is a highly classified and sensitive area. The problems of security attached to the conduct and control of such a classified training program are complex and varied. Using CAI on the TACFIRE system simplifies and reduces the security problems and procedures to those already established for the TACFIRE system. The TACFIRE system is a classified system. Personnel operating or utilizing the system must be cleared for access to the system. The Tape Transport Cartridge (TTCs) which contain the operational programs are classified. At the present time, the TTCs containing the TACFIRE courseware are classified, even though the courseware contained therein is unclassified. Courseware, which is classified within current operational levels, would probably require no changes in the procedures currently in use.

It is recommended that classified courseware be developed covering the TACFIRE functional areas applicable to the employment and use of nuclear weapons. Because this is a classified and highly sensitive area, such a project should be handled as a separate and distinct entity. What would be required is a developer that is cleared at the appropriate level, has the proven capability to develop and install TACFIRE courseware, and has worked in and has knowledge of the subject matter area.

6. Develop a Computerized Production System for Generating Exercises

A major problem in exercising TACFIRE operations personnel is that the system reacts very quickly. For example, a given simple, uncomplicated fire mission may take as little as 15 seconds for an experienced operator to display, review, and process in an ongoing tactical situation. To obtain this level of experience, the operator should be exposed to exercises which increase in intensity and complexity from light load to

heavy load exercises. Properly programmed levels of activity and complexity should result in increased operational proficiency to the desired level.

The problem arises in preparing such exercises. The man-hours expended in manually establishing data bases and inputting tactical data, such as fire missions, are horrendous, comparable perhaps to the time required to fire a .50-cal machine gun versus the time required to load the ammunition belts by hand.

Each exercise needs to be developed manually. The events (data) for these exercises are translated into binary bits which are input from the peripheral devices or from the ACC and stored in the computer and acted upon. A computerized production system which would input the binary bits for an exercise would appear to be a necessary, needed requirement to fully exercise TACFIRE operations personnel so that they can attain and maintain the desired level of proficiency.

It is not a perfect world and people make mistakes; problem situations arise that need to be taken care of. It is the operator's function to recognize these problem situations and take the actions that are required when and where they occur.

The TACFIRE training program should provide the opportunity for the operator to recognize and take care of problem situations. This is done by interjecting problem situations in the exercises and observing and reporting what was done correctly and what was not done (and the consequences). A computerized production system would have this capability.

Other advantages of a computerized production system would be to prepare TACFIRE personnel to operate anywhere in the world. Data bases would be established for a specific locale and targets and fire missions would be selected in accordance with the local terrain (mountains, desert, jungle, climate) and expected tactical situation. The problem input tapes generated would exercise TACFIRE personnel in conducting tactical operations at that locale with the problems attendant upon such operations built into the exercise. These could be further developed to produce unit exercises similar to the former Army Training Tests for purposes of both unit training and unit testing. Savings in money, ammunition, and time can be generated in this area.

It is recommended that a project be undertaken to determine the specifications for a production system that would provide the required exercises to bring TACFIRE operations personnel up to the desired level of proficiency and, once attained, maintain them at that level. Such exercises should have capability for expansion into unit training and test modules.

#### 7. Develop Embedded Training Programs for Other Tactical Data Systems

Current training procedures for new systems embody the training of personnel who in turn train other personnel. The training investment is in people. However, schedules slip, other assignments are made, personnel retire or leave the service, or the system changes--all requiring a

heavy personnel burden and cost to provide the relatively few people required when systems are installed, tested, and become operational. Such systems are normally installed on a staggered schedule with fairly low personnel requirements for a specific system. People are a transitory asset that disappears when the people are no longer available.

A suggested feasible alternative that reduces the number of people required, but not the requirement for a nucleus of trained personnel, is a permanent type of training program which becomes an integral part of the system. The characteristics of such a program are: it is always available (permanent), is easily and readily changed, produces operationally trained quality personnel within known time limits, minimizes the number of OJT hours to become operationally ready, and provides training products (TAIS, Criterion and Enabling Objectives, Criterion test items, courseware) that are easily reviewed by the agencies involved so they are each confident that their own needs, responsibilities, and requirements are satisfied.

Such a program as the TACFIRE AI system meets these requirements. The development cycle is relatively short. The installation cycle, including execution on-line and content (tactical doctrine) review, is short (with a ratio of 2 to 3 hours of "direct user" (command) participation and review for each hour of operationally ready courseware produced). Changes are made quickly, easily, and economically on-line. The training courseware is reproducible--additional computer tapes containing courseware take only a few minutes to duplicate from the original.

It is recommended that permanent AI training programs for other tactical data systems be developed using the TACFIRE AI approach and methodology. Such a training program as TACFIRE AI reasonably assures the quality of trained personnel, is standardized, well documented, can be scheduled closely, is readily changed to meet changes in equipment, programming, and tactical doctrine, and is a permanent readily accessible and immediately promulgated asset. Such a program should be and can be developed early in the procurement and development cycle to train test and acceptance personnel, as well as tactical users of the systems.

#### 8. Develop a Simplified Reference Manual for ACC Operators

Long lists of mnemonics and message functions characterize the TACFIRE computer system. TACFIRE training is designed to provide students with a working knowledge of the system, but undoubtedly ACC operators will need to turn to reference material to check on:

- a. Mnemonic definitions and entry requirements,
- b. Specific actions sequences such as system initialization procedures, and
- c. Error and warning message interpretation and recovery procedures.



It is recommended that a simplified reference manual be developed for two specific target groups:

- a. ACC operators and other FDC personnel working under operational conditions, and
- b. ACC operator trainees.

This reference work should include:

- a. A mnemonics dictionary which includes entry requirements, entry limitations, legal mnemonic entries, and related (optional and required) mnemonics,
  - b. A functional index of procedures, actions, and message formats, and
  - c. An alphabetical list of error and warning messages including their interpretation and recovery procedures.
9. Develop or use TACFIRE Modules to Train Reserve Units Affiliated with Active Army Units

Reserve units currently train periodically for short intensive periods with their affiliated active Army units. Much of this time is probably spent getting "on board." It is conceivable for such a system as TACFIRE that such training periods would be restricted to "individual" or "familiarization" rather than "unit" training because of the complexity of the system.

Training of Reservists in TACFIRE utilizing remote display devices (CRTs) tied into a computer containing the courseware during Reserve training could result in these units being able to perform at a higher degree of proficiency during the short time they train with their parent active Army affiliate. This would enhance the training efficiency of this very important short period of unit training.

ARI currently has remote devices at Fort Benning, Ga., Fort Sill, Okla., and other locations tied into a central computer containing PLANIT courseware. A similar arrangement can be established for the Reserve units. TACFIRE can be run on such a system directly or with minor modification.

It is recommended that TACFIRE courseware be used, adapted, or developed to train Reserve units. A project should also be established to determine the requirements for such a program.

## APPENDIX A

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